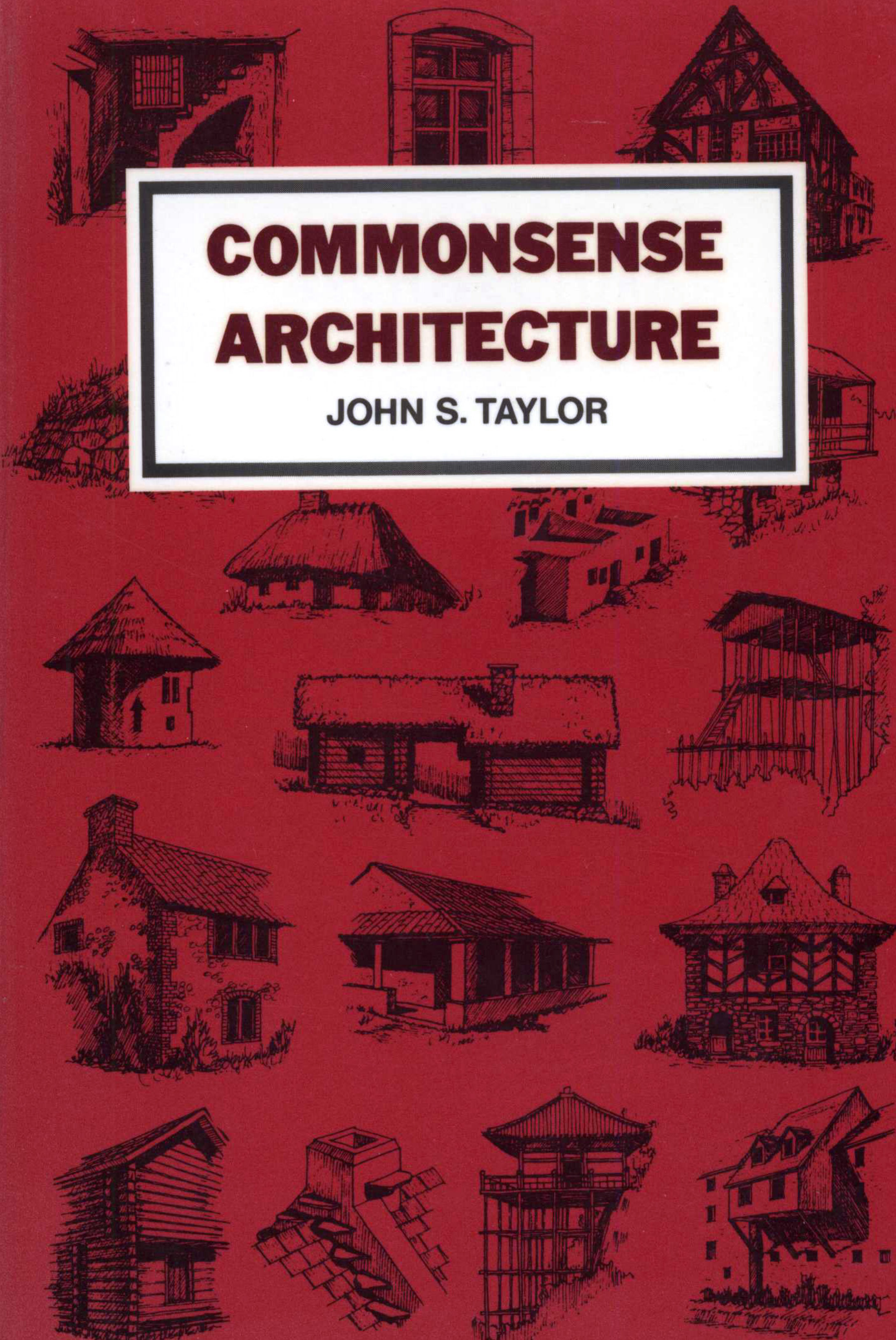
COMMONSENSE ARCHITECTURE

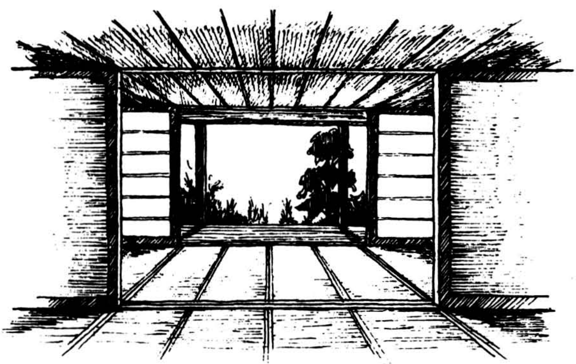
JOHN S. TAYLOR



COMMONSENSE ARCHITECTURE

A CROSS-CULTURAL SURVEY OF PRACTICAL DESIGN PRINCIPLES

JOHN S. TAYLOR



W · W · NORTON & COMPANY
New York London

Published simultaneously in Canada by Penguin Books Canada Ltd,
2801 John Street, Markham, Ontario L3R 1B4
Printed in the United States of America

First published as a Norton paperback 1986

Library of Congress Cataloging in Publication Data
Taylor, John S.
Commonsense Architecture
1. Vernacular Architecture. I. Title.
NA208.T39 1983 720 82–14522

ISBN 0-393-30330-6

W. W. Norton & Company, Inc., 500 Fifth Avenue, New York, N. Y. 10110
W. W. Norton & Company Ltd., 37 Great Russell Street, London WC1B 3NU

2 3 4 5 6 7 8 9 0

TO MY FATHER AND HIS SISTER, MARTHA

I am especially grateful for the assistance of Nita Lescher, Jim Mairs, Janet Byrne, Clee and Suzanne Edgar, Etsuko Penner, the Government of Japan, and Pan American Airways, for the support from all my family and friends, and most importantly, for the pragmatic spirit of history's anonymous builders.

CONTENTS

INTRODUCTION

" WHEN ONE HAS COMPLETED THE NECESSARY ... ONE IMMEDIATELY COMES UPON THE BEAUTIFUL AND THE PLEASING."

VOLTAIRE

THE STRAIGHTFORWARD RESPONSE TO BOTH HUMAN NEEDS AND ENVIRONMENTAL FORCES GIVES FOLK HOUSES OF THE WORLD A REFRESHING QUALITY. THEIR BEAUTY LIES IN THE STRONG LINK BETWEEN FORM AND PURPOSE AND IN THE ABSENCE OF COSMETICS OR REDUNDANCY.

A SCARCITY OF RESOURCES LED HISTORY'S ANONYMOUS BUILDERS TO ACHIEVE A HIGHLY ECONOMICAL AND PRACTICAL FORM OF UNSELFCONSCIOUS ARCHITECTURE ROOTED IN TIMELESS PRINCIPLES OF REASON RATHER THAN IN TEMPORARY FASHIONS OR WHIMS.

ALONG WITH MANY BENEFITS, ADVANCED TECHNOLOGY HAS ALLOWED US TO BE IMPRACTICAL, WITH THE KNOWLEDGE THAT ARTIFICIAL MEANS ARE AVAILABLE TO OVERCOME INEFFICIENCY. RECENT SHORTAGES OF CAPITAL AND ENERGY RESOURCES SHOULD FORCE US TO RECOGNIZE THAT PRACTICALITY MUST BE AN ESSENTIAL ELEMENT IN CONTEMPORARY ARCHITECTURE. IN THIS RESPECT VERNACULAR FOLK ARCHITECTURE CAN TEACH US A GREAT DEAL.

COMMONSENSE ARCHITECTURE DEPICTS INDIGENOUS ARCHITECTURE'S RESPONSIVENESS TO HUMAN NEEDS AND TO THE ENVIRONMENT, WITH EXAMPLES FROM ALL PARTS OF THE WORLD. THE BOOK IS NOT A TREATISE AGAINST TECHNOLOGY, BUT RATHER A CATALOGUE OF COMMONSENSE PRINCIPLES THAT CAN HELP US USE TECHNOLOGY AS AN EFFICIENT TOOL INSTEAD OF AS A CLOAK FOR INEFFICIENT DESIGNS.

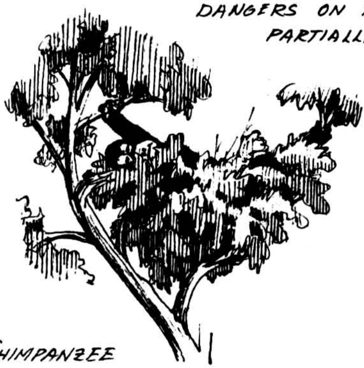
THE FIRST SECTION ILLUSTRATES HOW BUILDINGS RESPOND TO EXTERNAL ENVIRONMENTAL FACTORS SUCH AS CLIMATE AND PREDATORS. THE SECOND SECTION DESCRIBES WAYS IN WHICH VARIOUS ACTIVITIES SUCH AS SLEEPING AND COOKING ARE ACCOMMODATED WITHIN DWELLINGS. AND THE FINAL SECTION INVESTIGATES THE MATERIALS AND CONSTRUCTION PRACTICES USED TO BUILD SHELTERS. TO MAINTAIN A PURELY FUNCTIONAL APPROACH TO FOLK ARCHITECTURE, CERTAIN CULTURAL INFLUENCES – RELIGION AND POLITICS, FOR EXAMPLE – HAVE NOT BEEN DISCUSSED. IT SHOULD BE NOTED, HOWEVER, THAT MOST OF THESE TRADITIONS HAVE A RATIONAL, UTILITARIAN BASIS. TO INSURE THEIR CONTINUED USE, THESE IDEAS HAVE GRADUALLY BEEN INCORPORATED INTO THE CULTURAL LORE THAT GUIDES BUILDERS. IN SOME CASES A PRACTICE MAY THRIVE EVEN AFTER THE REASON FOR IT HAS BEEN FORGOTTEN.

COMMONSENSE ARCHITECTURE WAS CREATED IN THE HOPE THAT THE WISDOM THAT SHAPED THE VERNACULAR ARCHITECTURE OF THE PAST WILL HELP US REDUCE OUR DEPENDENCE ON RESOURCES BY REVIVING OUR USE OF RESOURCEFULNESS.

SECTION I - PROTECTION FROM THE ENVIRONMENT

NATURE AS PROVIDER OF SHELTER

SHELTERS EVOLVED TO GIVE PROTECTION FROM THE HOSTILE ASPECTS OF THE ENVIRONMENT, PRIMARILY HARSH WEATHER AND THREATS FROM OTHER ANIMALS. FOR EONS TREE-DWELLING APES HAVE CONSTRUCTED CRUDE LEAF AND TWIG PLATFORMS IN THE TREES TO RAISE THEMSELVES ABOVE THE DANGERS ON THE GROUND AND TO PARTIALLY WARD OFF THE RAIN AND HOT SUN.

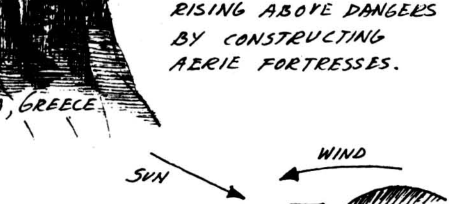


CHIMPANZEE IN SLEEPING PLATFORM

ARBOREAL JUNGLE TENT USED IN A BIOLOGICAL RESEARCH PROGRAM AMAZON JUNGLE, 1980

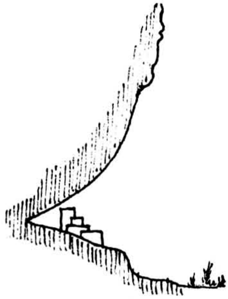
METÉORA, GREECE

PEOPLE HAVE CONTINUED THIS PRACTICE OF RISING ABOVE DANGERS BY CONSTRUCTING AERIE FORTRESSES.

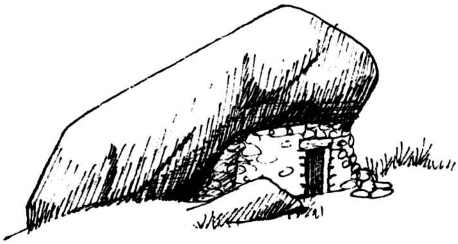


APPROPRIATE SITING CAN GREATLY REDUCE UNWANTED ENVIRONMENTAL IMPACTS. ELEVATION, ORIENTATION, AND WIND PROTECTION ARE CAREFULLY CONSIDERED BY BOTH ANIMALS AND TRADITIONAL INDIGENOUS BUILDERS.

MOST PRIMITIVE DWELLINGS SHOW A STRONG SENSITIVITY TO LOCAL CONDITIONS. OUT OF NECESSITY THEY TAKE MAXIMUM ADVANTAGE OF THE NATURAL AMENITIES TO GAIN INCREASED COMFORT AND PROTECTION.



CLIFF DWELLINGS
MESA VERDE,
COLORADO



SHELTER BUILT UNDER
A PROJECTING BOULDER
PORTUGAL

WHERE CONDITIONS WERE RIGHT, BUILDERS OFTEN CHOSE TO CREATE SHELTERS BY CARVING THEM OUT OF THE EARTH.

DWELLINGS PARTLY CUT
INTO CLIFFS AND PARTLY
BUILT OUT FROM THEM
SETENIL, SPAIN

ELABORATE FACADES WERE ADDED TO MANY DWELLINGS CARVED OUT OF SOFT STONE CLIFFS.
TOURAINE, FRANCE

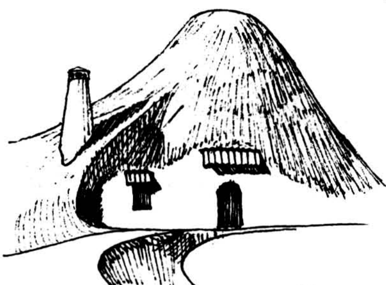
FOR MILLIONS OF YEARS MANY ANIMALS HAVE USED UNDERGROUND SANCTUARIES FOR PROTECTION FROM COLD, HEAT, RAIN, SNOW, PREDATORS, ETC. EARLY MAN LEARNED A GREAT DEAL ABOUT SHELTERS FROM THE OTHER ANIMALS AND SAW THE VALUE OF THE BURROWED HOME.

SMALL ANT COLONY

DWELLINGS HOLLOWED OUT OF NATURAL CONES OF POROUS LIMESTONE, OR TUFA.

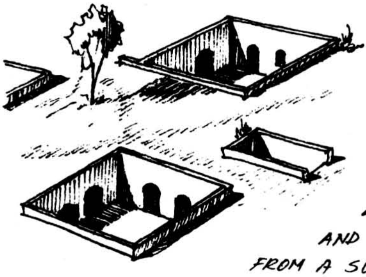
CAPPADOCIA, TURKEY

FRONT VIEW AND PLAN OF HOUSES CUT OUT OF A VOLCANIC STONE, CALLED TUFF, IN MASSAFRA, ITALY. THE FAN-SHAPED ROOMS LEFT A MINIMAL HOLE IN THE FACE OF THE FRAGILE ROCK AND HAD NO DARK CORNERS.

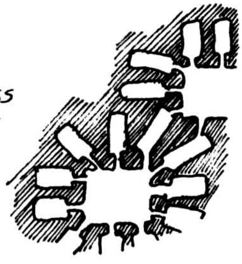


HOUSE DUG INTO ROCK CONE COMPLETE WITH A FINISHED FACADE AND A CHIMNEY

GUADIX, SPAIN

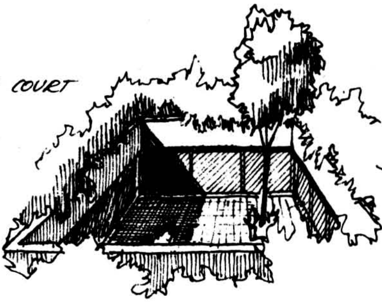


DWELLINGS DUG OUT OF SOFT LOESS SOIL AND RADIATING FROM A SUNKEN CENTRAL COURT (NORTHERN CHINA)



PLAN VIEW

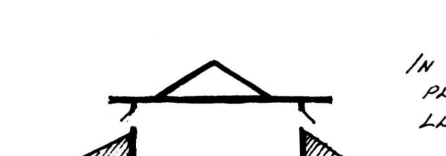
THE SUNKEN COURT CONCEPT IS STILL USED EFFECTIVELY TODAY.



JOHN BARNARD'S ECOLOGY HOUSE OSTERVILLE, MASSACHUSETTS

SOME EARTH-SHELTERED HOMES ARE DUG INTO A HILL SO THAT ONLY ONE WALL (USUALLY TO THE SOUTH) IS EXPOSED FOR ACCESS AND LIGHT.

BANKED HOUSE, AMERICAN MIDWEST



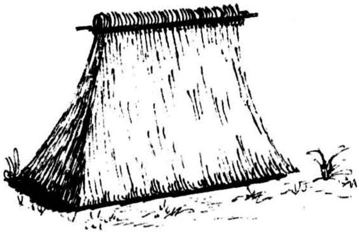
IN HIS COOP HOMESTEAD PLANS IN 1942, FRANK LLOYD WRIGHT PROPOSED SHELTERING THE HOUSE WITH AN EARTH BERM.

STAYING DRY

OFFERING PROTECTION FROM THE RAIN IS A PRIMARY GOAL FOR SHELTERS IN MOST CLIMATES.

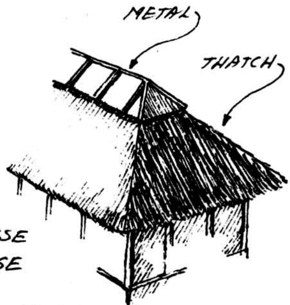
HUT ON ALOR ISLAND NEAR BORNEO

THIS SIMPLE SHELTER SERVES AS BOTH A RAIN HAT AND SUN SHADE.



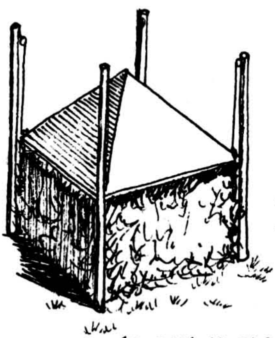
HOUSE ON FLORES ISLAND

THE STEEP THATCH ROOF IS DESIGNED TO SHED THE HEAVY INDONESIAN RAINS.



JAPANESE HOUSE

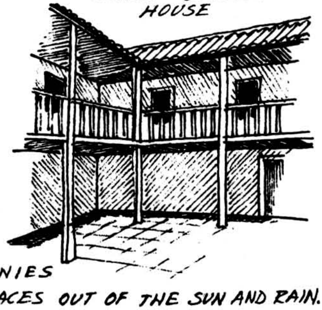
THE METAL CAP ALONG THE PEAK OF THE ROOF PROTECTS THIS OFTEN LEAKY SPOT IN THATCH ROOFS.



HAY STORAGE SHED, HOLLAND

AS HAY IS ADDED THE ROOF IS RAISED WITH ROPES FROM THE POLES. THE ROOF SHEDS THE RAIN, WHILE AIR CAN STILL GET IN TO DRY THE HAY.

EARLY GREEK HOUSE



COVERED INTERIOR BALCONIES CREATE LIVING SPACES OUT OF THE SUN AND RAIN.

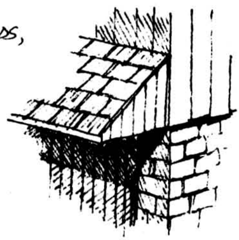
THE SMALL HIP SEGMENT ON THIS GABLE ROOF PROTECTS A SMALL PORCH THAT CAN BE USED IN ALL WEATHER AS A PLACE TO WORK AND TO DRY FOOD AND CLOTHES.

COVERED PORCH
ON LAKE GENEVA, SWITZERLAND

THIS HOUSE IN NORTHWEST NEW GUINEA NOT ONLY GIVES GOOD PROTECTION FROM THE HEAVY RAINS BUT ALSO INSURES COOLING THROUGH-VENTILATION.

KAMBOT HOUSE
SEPIK, NORTHWEST NEW GUINEA

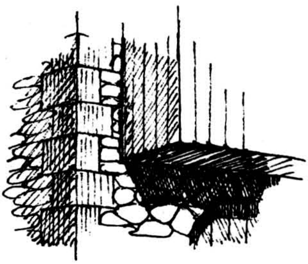
SMALL ROOFS, HOODS, AND CANTILEVERED OVERHANGS ARE ALSO VERY EFFECTIVE DEVICES FOR DIVERTING THE RAIN.



DOOR HOOD ON PENNSYLVANIA FARMHOUSE

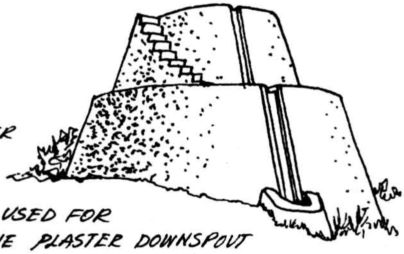
PENTICE, OR PENT ROOF, ON A BARN IN PENNSYLVANIA

CANTILEVERED OUTSHOT ON BARN IN DELAWARE



HERE THE OVER-HANGING UPPER FLOOR ACTS AS A RAIN HOOD FOR LOWER LEVEL.

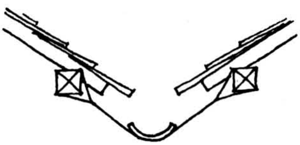
IN AREAS WHERE FRESH WATER WAS A VERY LIMITED COMMODITY MANY INNOVATIVE SYSTEMS EVOLVED FOR THE COLLECTION AND STORAGE OF RAINWATER.



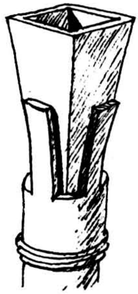
FIELD SHELTER
SOUTHERN ITALY

THE FLAT ROOF IS USED FOR DRYING CROPS AND THE PLASTER DOWNSPOUT CARRIES RAINWATER TO A CISTERN (1600)

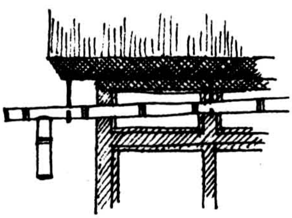
GUTTERS AND DOWNSPOUTS ARE THE MAIN TOOLS FOR WATER COLLECTION:



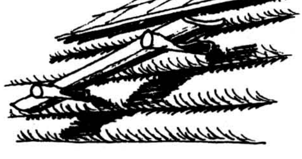
JAPANESE SLUNG BAMBOO GUTTER SERVING TWO ROOFS



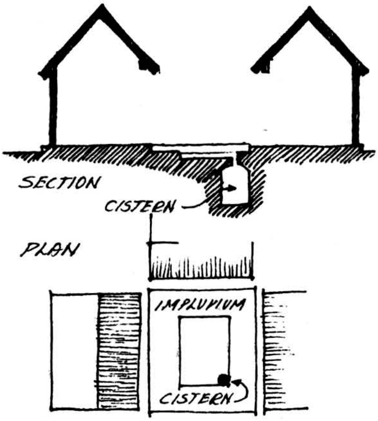
JAPANESE WOOD AND BAMBOO DOWNSPOUT (1700's)



JAPANESE BAMBOO GUTTER AND DOWNSPOUT HUNG FROM METAL BRACKETS (1659)



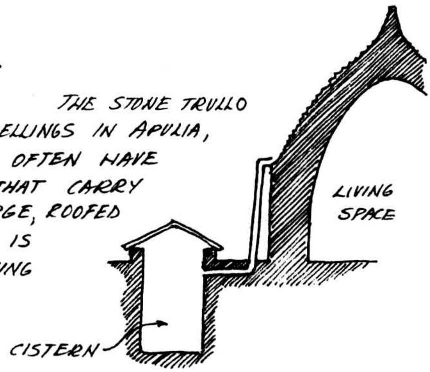
LOG GUTTER
FORT CLATSOP, OREGON
(1805)

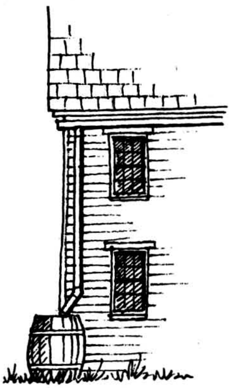


BENIN HOUSE
SOUTHERN NIGERIA

THE CENTRAL COURTYARD, OR IMPLUVIUM, ACTS AS A RAINWATER COLLECTION BASIN THAT EMPTIES INTO A CISTERN BURRIED AT ONE CORNER.

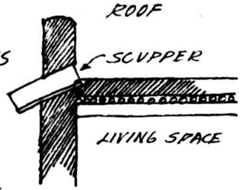
THE STONE TRULLO DWELLINGS IN APULIA, ITALY OFTEN HAVE DOWNSPOUTS THAT CARRY RAINWATER INTO LARGE, ROOFED CISTERNS. THIS WATER IS USED BOTH FOR DRINKING AND FOR WATERING CROPS.





IN THE AMERICAN WEST, THE CUSTOMARY WATER BARREL WAS A AN ABOVE-GROUND CISTERN FOR RAINWATER.

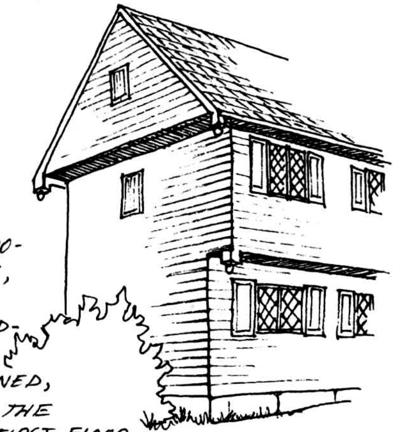
PUEBLO DWELLING
ROOF



SUDDEN RAINS IN THE AMERICAN SOUTHWEST ARE QUICKLY DRAINED FROM THE FLAT EARTH ROOFS BY SCUPPERS THAT USUALLY DIRECT THE WATER INTO BARRELS.

PROTECTING THE WALLS OF THE HOUSE FROM THE RAIN IS IMPORTANT FOR THEIR PRESERVATION, AND VARIOUS DESIGN ELEMENTS HAVE EVOLVED TO MEET THIS NEED.

CZECHOSLOVAKIAN HOUSE
THE GABLE WALL IS PROTECTED BY A ROOF PROJECTION AND A CANTILEVERED, OR JETTIED, SECOND FLOOR.



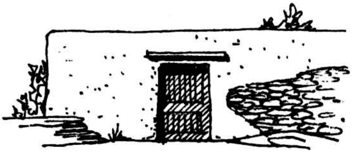
THE JETTIED GABLE PROTECTS THE END WALL BELOW, THE LARGE ROOF OVERHANG PROTECTS THE FRONT SECOND-FLOOR WALL, AND THE CANTILEVERED, OR GARRISONED, SECOND FLOOR PROTECTS THE FRONT WALL OF THE FIRST FLOOR.

PAUL REVERE'S HOUSE
BOSTON, MASSACHUSETTS
(BUILT IN 1660)

MEXICAN HOUSE
NEAR HIDALGO
THE FANNED GABLE OF HAND-SPLIT SHAKES PROTECTS THE SOFT MUD BRICK WALL BELOW.

COTTAGE
CAMBRIDGESHIRE, ENGLAND
THE SLOPING PENTICE BOARDS PROTECT THE GABLE WALL.

MASONRY WALLS ARE PARTICULARLY VULNERABLE TO DETERIORATION WHEN EXPOSED TO MOISTURE, SO THEY REQUIRE SPECIAL PROTECTION.



SIFNOS ISLAND, GREECE

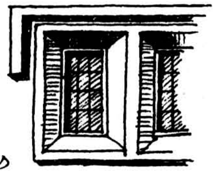
PLASTER OVER THESE ROUGH STONE WALLS PROTECTS THE SOFT MASONRY.

FIELD WALL, GREECE

THE PLASTER CAP PROTECTS THE STONEWORK BELOW.

PARAPET WALL, MEXICO

SLOPING TILES KEEP THE RAIN FROM EATING AWAY THE SOFT MUD BRICK WALLS.

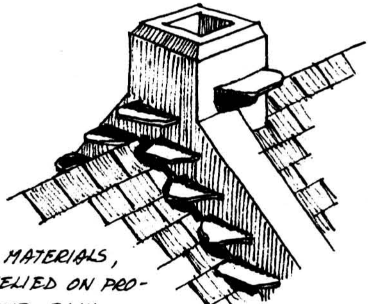


MEDIEVAL WINDOW ENGLAND

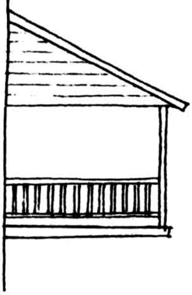
THE DRIP BAND AROUND THE UPPER SIDE OF THE WINDOW PREVENTS WATER FROM FLOWING DOWN THE WALL AND INTO THE SASH AND SILL JOINTS.

DRIP COURSE ENGLAND

THE PROJECTING COURSE OF BRICKS KEEPS WATER FROM FLOWING DOWN THE WALL AND DAMAGING THE MASONRY.



LACKING MODERN FLASHING MATERIALS, EARLY BUILDERS IN WALES RELIED ON PROJECTING SLATES TO KEEP THE RAIN AWAY FROM THE ROOF / WALL JUNCTION.

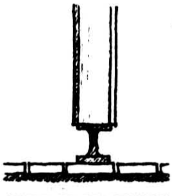


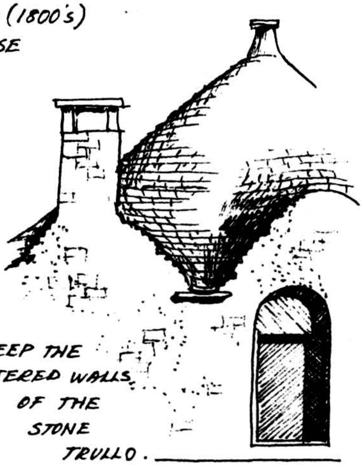
PROJECTING LOGGIA, ST. AUGUSTINE, FLORIDA (1700'S)
THE SLOPED FLOOR PREVENTS STANDING WATER FROM ROTTING THE FLOOR.

BANNISTER JOINT, ST. AUGUSTINE, FLORIDA (1700'S)

THE V-JOINT KEEPS WATER FROM COLLECTING IN THE JOINT AND ROTTING THE WOOD.

PORCH POST, VIRGINIA (1800'S)
THE METAL BASE PROTECTS THE POST FROM WATER THAT RUNS OFF THE PORCH.

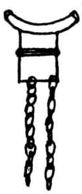




STONE SCUPPERS KEEP THE WATER OFF THE PLASTERED WALLS OF THE STONE TRULLO.

STONE TRULLO
APULIA, ITALY (1600'S)

JAPANESE GUTTER AND DOWNSPOUT



THE WATER FLOWS ALONG THE CHAINS TO THE GRAVEL BED BELOW AND DOESN'T SPLASH THE HOUSE WALL.

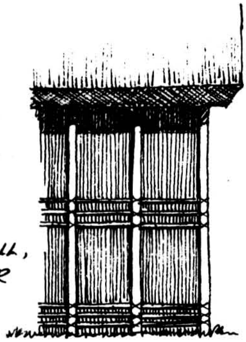
GRAVEL BED

JAPANESE FENCE POST (1600'S)
THE BASE IS STONE TO RESIST ROT AND THE UPPER PART IS WOOD.

IF WATER VAPOR IS ALLOWED TO CONDENSE ON WOOD OR OTHER PLANT BUILDING MATERIALS IT WILL CAUSE MILDEW AND ROT. A VARIETY OF TECHNIQUES CAN PREVENT THIS.

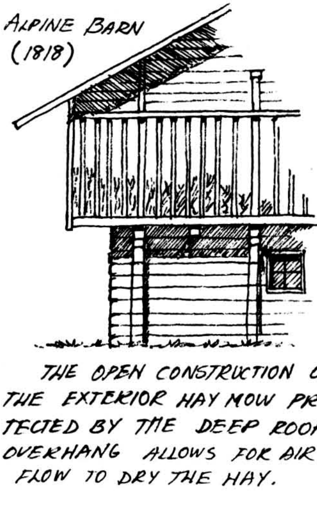
PARASOL ROOF WITHOUT WALLS, SAMOA

IN HOT, HUMID AREAS IT IS IMPORTANT TO PROMOTE GOOD FLOW-THROUGH VENTILATION TO PREVENT CONDENSATION.



OPEN REED WALL, MADAGASCAR

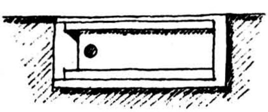
ALPINE BARN (1818)



THE OPEN CONSTRUCTION OF THE EXTERIOR HAY MOW PROTECTED BY THE DEEP ROOF OVERHANG ALLOWS FOR AIR FLOW TO DRY THE HAY.

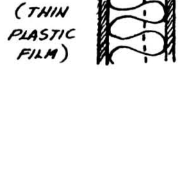
AS MOIST AIR PASSES THROUGH A WALL FROM THE WARM SIDE TO THE COLD SIDE, IT MAY REACH ITS DEW POINT AND CONDENSE WITHIN THE WALL, CAUSING MILDEW AND ROT. VAPOR BARRIERS IN MODERN HOMES ARE INSTALLED TO STOP THE MOISTURE BEFORE IT GETS INTO THE WALL.

ROT CAUSED BY CONDENSATION IN A COOL, MOIST CRAWL-SPACE IS CURBED WITH FOUNDATION VENTS.



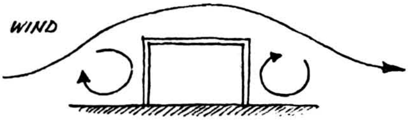
SLIDING VENT, QUEBEC

WALL SECTION:



PROTECTION FROM THE WIND

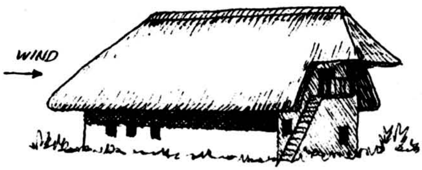
HOUSE FORMS THAT OFFER LITTLE AIR RESISTANCE AND CREATE NO TURBULENCE REDUCE THE STRUCTURAL AND THERMAL IMPACTS OF THE WIND.



WIND OVER THE RECTANGULAR HOUSE CREATES TURBULENT EDDIES, WHILE THE WIND FLOWS EVENLY OVER THE SEMICIRCULAR ONE.

LEAN-TO WIND SHELTER
AKSEHIR, TURKEY

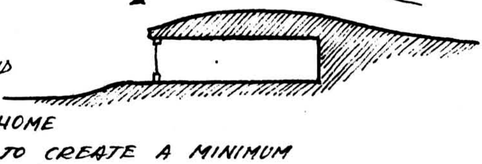
THE HOUSE BELOW HAS A ROOF SHAPED LIKE A BOAT'S HULL THAT HAS ITS BOW TURNED INTO THE WIND.



NORMANDY FARMHOUSE

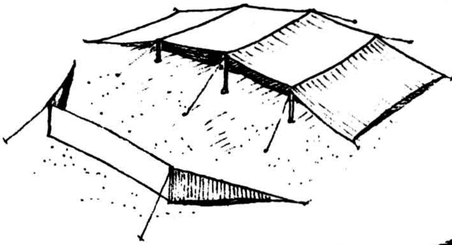
NEW ENGLAND SALTBOX
(1800'S)

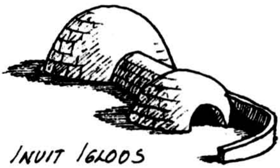
THE SALTBOX HOUSES OF NEW ENGLAND LET THE COLD NORTH WINDS GLIDE OVER THE LONG, SLOPING ROOF.



THE TERRAIN AROUND THIS CONTEMPORARY EARTH-SHELTERED HOME IS CONTOURED TO CREATE A MINIMUM OF AIR TURBULENCE.

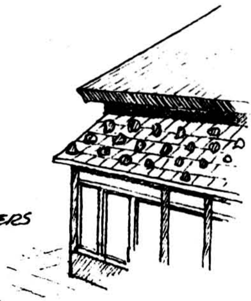
THE BACKSTRIP BY THIS ARAB TENT BREAKS THE HOT, SANDY DESERT WINDS.



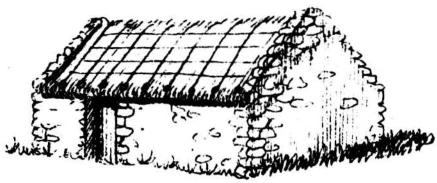


INUIT IGLOOS OFTEN HAD A WIND-SCREEN WALL BY THE ENTRANCE

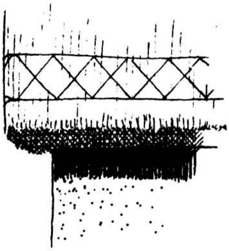
ROCKY MOUNTAIN TEPEE WITH WIND SCREEN



EARLY JAPANESE BUILDERS OFTEN PLACED STONES ON THE WOOD SHINGLES TO PREVENT THE WIND FROM BLOWING THEM OFF.

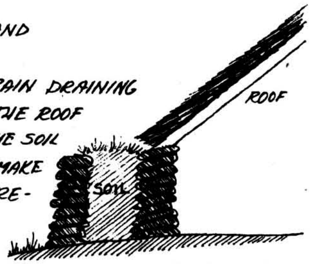


IN IRELAND, A ROPE NET WEIGHTED WITH STONES SECURES THE THATCH.



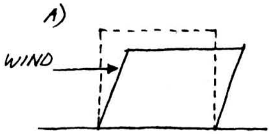
THIS ROPE BAND KEEPS THE WIND FROM PULLING UP THE EDGE OF THE THATCH ROOF.

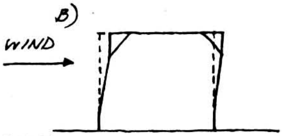
SUSSEX, ENGLAND (1699)



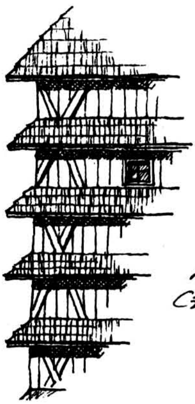
RAIN DRAINING OFF THE ROOF COMPACTS THE SOIL IN THE WALL TO MAKE THE HOUSE MORE RESISTANT TO THE WIND.

BLACK HOUSE
HEBRIDES, SCOTLAND



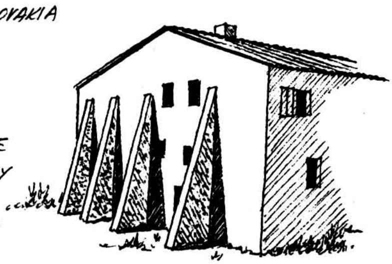


WIND PRESSURE ON AN UNBRACED FRAME (A) CAN PUSH IT OVER, BUT DIAGONAL BRACING AT THE CORNERS (B) WILL FORM RIGID JOINTS THAT CAN RESIST THE LATERAL FORCE.



THE DIAGONAL BRACES ON THE CORNER OF THIS BUILDING HELP IT RESIST THE LATERAL WIND PRESSURE.

HRONSEK,
CZECHOSLOVAKIA



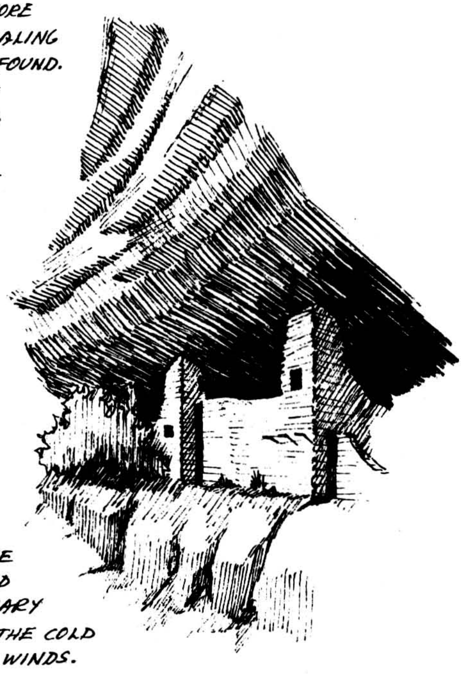
FOUR MASSIVE EXTERNAL SOLID MASONRY BUTTRESSES BRACE THIS BUILDING IN FRANCE AGAINST THE WIND.

Staying Warm

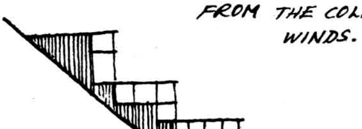
The earliest human settlements were centered in subtropical regions that had adequate food and water resources and arable land. As settlements spread to the more temperate regions, the problem of staying warm during the winter became critical. Caves offered limited protection, but as civilization grew, more successful ways of dealing with the cold were found.

The choice of the dwelling site was very important. The intention was to maximize the natural advantages of the site — such as terrain, geology, hydrology, vegetation, etc. — and minimize the impact of the cold.

The Anasazi Indians at Mesa Verde built their dwellings into rock cliffs. These niches faced south for the warming sun and gave sanctuary from the cold winds.



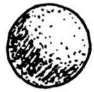
Balcony House
Mesa Verde, Colorado
13th century



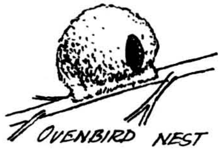
Hill Dwellings, Pakistan

In the mountains of Pakistan the people build their houses on steep, south-facing slopes to give shelter on the north and to capture the sun's warmth. This practice also leaves the entire river valley free for cultivation.

ANOTHER VERY EFFECTIVE WAY TO REDUCE A DWELLING'S EXPOSURE TO THE COLD IS TO USE BUILDING SHAPES THAT MAXIMIZE THE SPACE CONTAINED WHILE MINIMIZING THE EXPOSED SURFACE AREA.



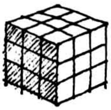
SPHERE
VOLUME = 36 UNITS^3
SURFACE AREA = 52.7 UNITS^2
VOLUME/SURFACE AREA RATIO = .68



OVENBIRD NEST

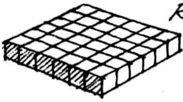
HEMISPHERE
VOLUME = 36 UNITS^3
SURFACE AREA = 62.78 UNITS^2
VOLUME/SURFACE AREA RATIO = .57

INUIT IGLOO

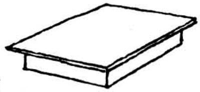


CUBE
VOLUME = 36 UNITS^3
SURFACE AREA = 65.4 UNITS^2
VOLUME/SURFACE AREA RATIO = .55

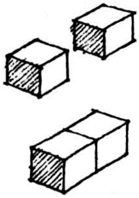
CANADIAN LOG CABIN



RECTANGULAR SOLID
VOLUME = 36 UNITS^3
SURFACE AREA = 96 UNITS^2
VOLUME/SURFACE AREA RATIO = .38



CONTEMPORARY HAWAIIAN HOUSE



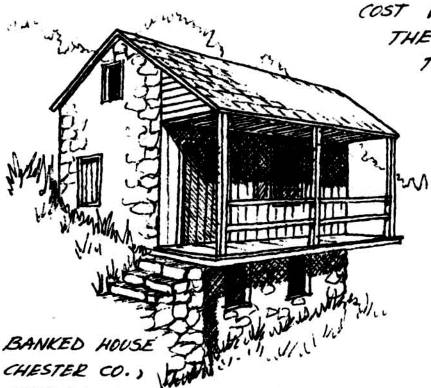
BY CLUSTERING MANY DWELLING UNITS IN A SINGLE MASS, THE EXPOSED SURFACE AREA CAN BE SIGNIFICANTLY REDUCED.

ACOMA PUEBLO
NEW MEXICO

SOME BEES AND WASPS USE HEXAGONAL TUBES IN HIVE BUILDING. THIS SHAPE ENCLOSES A GOOD DEAL OF VOLUME AND ALLOWS TIGHT PACKING OF THE MODULES FOR MINIMUM EXPOSURE.

SECTION OF HONEYBEE HIVE

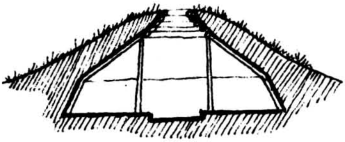
A SIMPLE, EFFECTIVE, AND LOW-COST WAY IN WHICH TO REDUCE THE IMPACT OF THE COLD IS TO USE THE EARTH TO TEMPER THE HOUSE. SLIGHTLY BELOW THE FROST LINE SOIL WILL REMAIN AT ABOUT 50° F. YEAR-ROUND.



BANKED HOUSE CHESTER CO., PENNSYLVANIA

BY BUILDING INTO A SLOPE THE LOWER FLOOR IS PROTECTED BY EARTH ON THREE SIDES.

TEMPORARY MOUNTAIN SHELTER, PAKISTAN - EARTH AND ROCKS ARE PILED UP AROUND PART OF THE STRUCTURE.

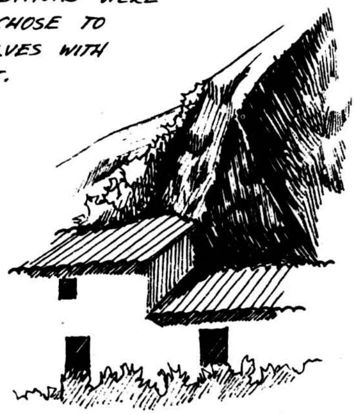


ESKIMO EARTH-SHELTERED DWELLING, CANADA - EARTH COVERS BOTH WALLS AND ROOF.

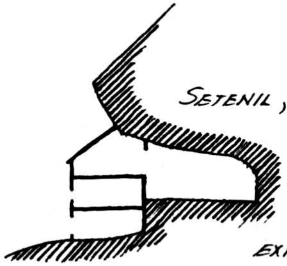
FARMHOUSE NORTHERN ICELAND - BUILT INTO HILLS WITH EARTH SHIELDING THE ROOF AND WALLS

LOG-END CAVE HOUSE, WEST CHAZY, NEW YORK — ONLY ONE WALL IS EXPOSED, WHILE EARTH PROTECTS THE REST OF THE HOUSE.

WHERE GEOLOGICAL CONDITIONS WERE FAVORABLE, MANY BUILDERS CHOSE TO COMPLETELY SHELTER THEMSELVES WITH THE LAND BY DIGGING INTO IT. THESE TROGLODYTE DWELLINGS BECAME VERY ELABORATE AND NOT AT ALL CAVE-LIKE.

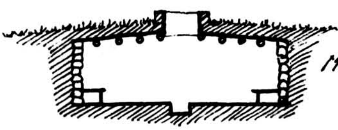


SETENIL, SPAIN



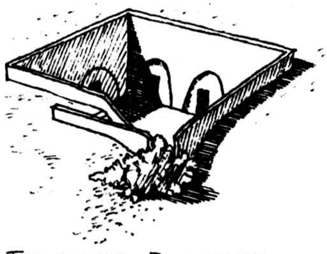
SECTIONAL VIEW

EXISTING ROCK CREVICES WERE EXPANDED AND VARIED STRUCTURES AND FACADES ADDED.



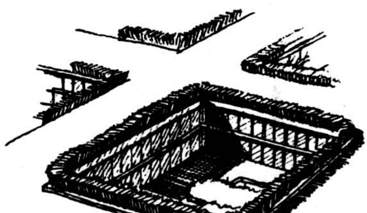
CEREMONIAL KIVA
MESA VERDE, COLORADO
(1200)

KIVAS WERE CIRCULAR STONE STRUCTURES SUNKEN INTO THE GROUND, WITH A WOOD CEILING THAT SUPPORTED A LAYER OF EARTH. ORIGINALLY THESE WERE CEREMONIAL BUILDINGS, BUT LATER DWELLINGS TOOK THIS SHAPE ALSO.



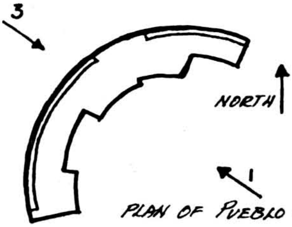
TROGLODYTE DWELLINGS
NORTHERN CHINA

THESE HOMES, CARVED INTO SOFT LOESS, LEFT THE SURFACE FREE FOR FARMING.



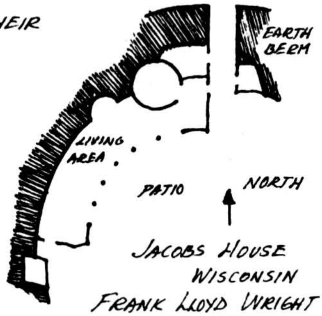
UNESCO HEADQUARTERS
PARIS

WHILE THE FIRST STEP TAKEN TO INSURE STAYING WARM IS TO MINIMIZE THE DWELLING'S EXPOSURE TO THE COLD, THE SECOND IS TO MAXIMIZE THE STRUCTURE'S ABILITY TO GAIN AND HOLD HEAT FROM NATURAL SOURCES, PRIMARILY THE SUN. SITING, ORIENTATION, MATERIALS USED, ZONING OF SPACES, AND PLACEMENT OF OPENINGS ARE ALL MAJOR CONSIDERATIONS IN ACHIEVING EFFECTIVE SOLAR HEAT GAIN.

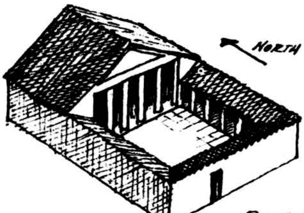


PLAN OF PUEBLO BONITO, NEW MEXICO (A.D. 919)

THE PUEBLO INDIANS AT PUEBLO BONITO ORIENTED THEIR LIVING COMPLEX SO THAT IT TOOK MAXIMUM ADVANTAGE OF THE WINTER SUN FROM DAWN (1) TO DUSK (2) WHILE PROVIDING SHADE FROM THE HOT AFTERNOON SUN IN SUMMER (3).

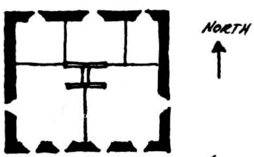


JACOBS HOUSE
WISCONSIN
FRANK LLOYD WRIGHT USED THE SAME ORIENTATION PRINCIPLES HERE IN 1943.



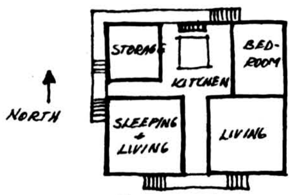
ROMAN HOUSE (A.D. 50)

THIS PLAN OFFERED A PROTECTED SUNNY COURT PLUS A LARGE SOUTHERN EXPOSURE FOR THE MAIN LIVING SPACE



PLAN OF QUEBEC HOUSE (1832)

NOTE THE PREDOMINANCE OF WINDOWS ON THE SOUTH SIDE FOR SOLAR HEAT GAIN.



PLAN OF SWISS HOUSE

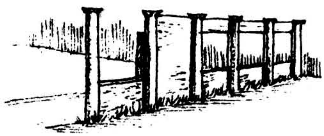
THE ZONING OF SPACES IN THIS HOUSE PUTS THE MAJOR LIVING AREAS ON THE SUNNY SOUTH SIDE WHILE STORAGE AND OTHER LESS USED SPACES ARE ON THE NORTH.

SOUTH DAKOTA FARMHOUSE
EARLY 20TH CENTURY

THIS HOUSE IS ORIENTED SO THAT THE MAJOR LIVING SPACE HAS A WARM, PROTECTED SOUTHERN EXPOSURE. THE KITCHEN/WORK EL ON THE LEFT (WEST) SHADES MUCH OF THE SOUTH WALL FROM THE HOT AFTERNOON SUN IN THE SUMMER.

COMPASS TERMITE MOUND
AUSTRALIA

THESE TALL (UP TO 13 FEET) BLADE-LIKE MOUNDS ARE ORIENTED ON A PRECISE NORTH/SOUTH LINE. THE TERMITES SPEND THE MORNINGS ON THE EAST SIDE AND THEN MOVE TO THE WEST (WITH THE SUN) IN THE AFTERNOON.

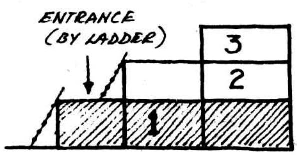


WALL OF PUBLIC BATHS
POMPEII (80 B.C.)

THIS SOUTH-FACING GLAZED WALL ADDED A LARGE AMOUNT OF SOLAR HEAT TO THE BATHING SPACES INSIDE.

COLONIAL SALTBOX HOUSE
NEW HAMPSHIRE (1860's)

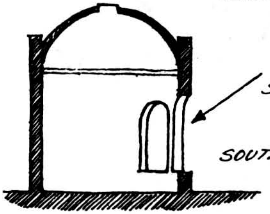
THE MAJORITY OF FIRST- AND SECOND-FLOOR WINDOWS FACED SOUTH FOR SOLAR HEAT GAIN WHILE MOST OF THE NORTH SIDE WAS ROOF TO OFFER PROTECTION FROM THE NORTH WINDS.



SECTION THROUGH ACOMA PUEBLO
NEW MEXICO (A.D. 900)

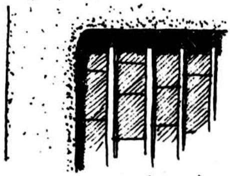
STORAGE SPACES (1) AND SLEEPING AREAS (2) TAKE UP LOWER AND NORTH-FACING PARTS OF BUILDING WITH THE MAIN LIVING AREA (3) BEING ABOVE AND FACING SOUTH.

THE DESIRE FOR SOLAR HEAT AND NATURAL LIGHT PUT GREAT EMPHASIS ON THE DESIGN AND USE OF WINDOWS.

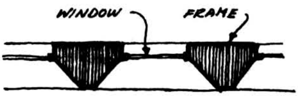


ROMAN HELIOCAMINUS
OSTIA (1ST CENTURY)

THE GLAZED SOUTH WALL ADDED INTENSE HEAT TO THE PUBLIC BATHS WHILE ALSO KEEPING IN THE WARM MOIST AIR.

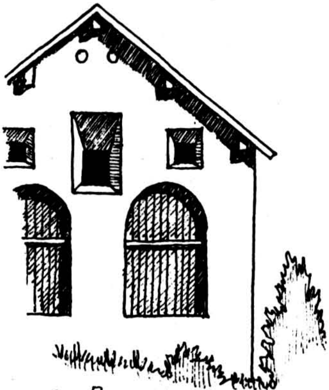


NEW MEXICO (1816)
PIECES OF SELENITE (CRYSTALLIZED GYPSUM) WERE USED AS A GLAZING.



PLAN OF STONE WINDOW FRAMES
MEDIEVAL ENGLAND

THE BEVELED SASH ADMITTED A WIDER ANGLE OF SUNLIGHT WITHOUT AN INCREASE IN ACTUAL WINDOW SIZE.

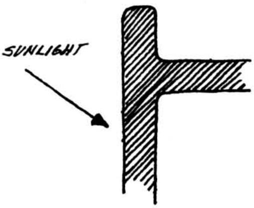


GUARDA, PORTUGAL
THIS STRUCTURE'S BEVELED SASH AND SILLS SERVE THE SAME PURPOSE.

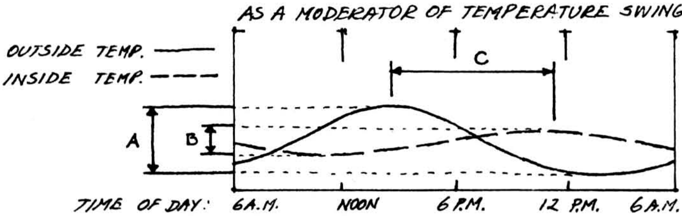
EARLY GREECE
PROJECTING SOLARIA ADDED HEAT AND LIGHT TO HOMES.

TUCSON, ARIZONA
THIS CONTEMPORARY HOUSE USES A SUNSPACE FOR DIRECT SOLAR GAIN.

Thermal Mass



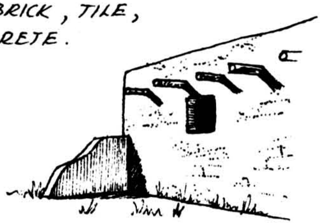
In hot, arid areas, dense heat-absorbing materials can moderate the large daily temperature fluctuations by absorbing heat during the day and slowly releasing it at night.



The degree of temperature variation outside (A) is greatly reduced inside (B) because the peak effect of the day's heat is delayed by the thermal mass to a time when it is counterbalanced by the cool of the night. Thus the building helps cool itself during the day and heat itself at night. This time delay in thermal effects is called the thermal lag.

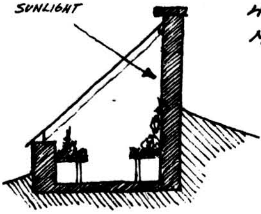
Materials traditionally used in this way include mud, adobe, stone, brick, tile, and concrete.

Mud and stone
Matakan house
Northern Camaroon

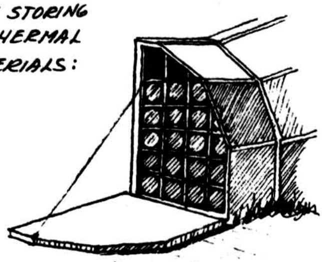


Adobe Pueblo
New Mexico

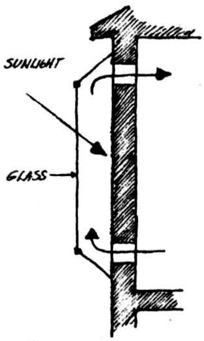
SOME OTHER METHODS OF STORING HEAT IN THERMAL MASS MATERIALS:



BRICK THERMAL WALL GREENHOUSE (1700's)

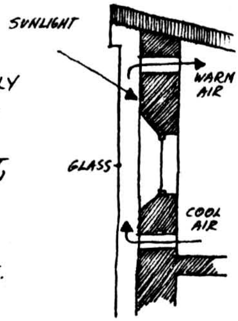


"DRUMWALL"
ALBUQUERQUE, NEW MEXICO
(WATER-FILLED DRUMS BEHIND GLASS)(1975)

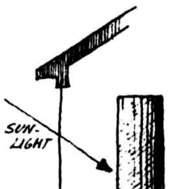


MORSE WALL (1881)

A THICK MASONRY WALL DIRECTLY BEHIND SOUTH-FACING GLASS CAN STORE A GREAT DEAL OF HEAT, AND AIR CAN FLOW BETWEEN THE WALL AND GLASS TO HELP DISTRIBUTE THAT HEAT.

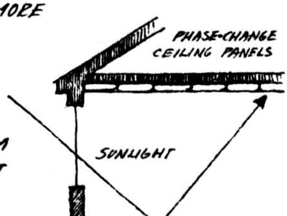


TROMBE WALL
(OR TROMWALL) (1981)



WATER COLUMNS
CONCORD, NEW HAMPSHIRE
(1980)

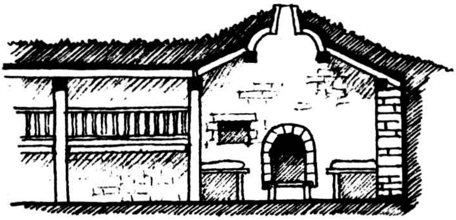
WATER CAN STORE MORE HEAT THAN OTHER MATERIALS, BUT SPECIAL CHEMI-CALS DESIGNED TO CHANGE PHASE (FROM SOLID TO LIQUID) AT CERTAIN TEMPERA-TURES CAN DO EVEN BETTER.



PHASE-CHANGE CEILING PANELS IN EXPERIMENTAL HOUSE, MASSACHUSETTS (1975)

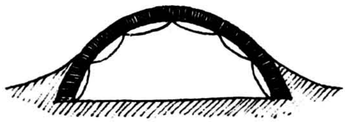
Natural Insulation

Many early dwellings were protected by a blanket of earth to act as an insulator.

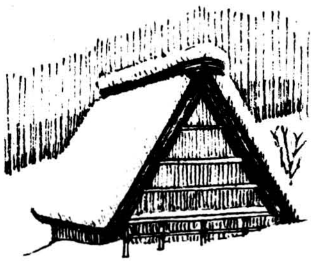


Early Armenian Dwelling
This earth-sheltered structure accommodated both humans (on the right) and animals.

Mandan Earth Lodge
Upper Missouri Valley



Inuit Igloo, Canada
Both ice and snow act as insulators against the sub-zero temperatures and harsh winds.



Farmhouse, Hokkaido, Japan

The roof is strong and steeply pitched to carry the load of a deep blanket of snow for insulation.

Log Cabin
Quebec
A layer of earth on the ceiling acts as insulation.

INSULATION

IN COLD WEATHER, ADDITIONAL LAYERS OF HEAVY FELT BLANKETS, OR MUNDAHS, WERE PLACED ON THE YURT FOR EXTRA INSULATION.

KIRGHIZIAN YURT

IN SOME INSTANCES HAY BALES WERE USED AS STRUCTURAL ELEMENTS, AND THEY ALSO PROVIDED GOOD INSULATION.

HAY BALE BARN NEBRASKA (1910)

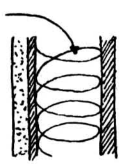
HAY BALES WERE (AND STILL ARE) USED AS INSULATION AROUND HOUSE FOUNDATIONS IN NEW ENGLAND. IN THE MIDWEST, MANURE IS SOMETIMES USED FOR THIS PURPOSE.

NEW HAMPSHIRE HOUSE (1850)

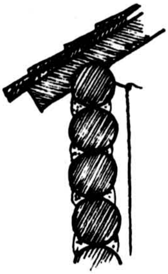
WASPS MAKE PAPER WITH WHICH THEY BUILD THEIR NESTS. THE THIN SHELL WITH MANY AIR POCKETS INSULATES AS WELL AS 16 INCHES OF BRICK.

WALL OF PAPER WASP NEST

EARLY HOME BUILDERS FILLED THE CAVITY BETWEEN INNER AND OUTER WALLS WITH PAPER OR STRAW FOR INSULATION. BUILDERS TODAY USE FIBERGLASS, CELLULOSE, FOAMS, AND OTHER MATERIALS.

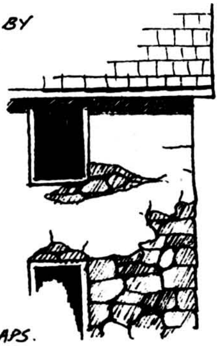


STOPPING HEAT LOSS CAUSED BY
THE INFILTRATION OF COLD AIR



CHINKING OF MUD PLUS SKINS HUNG ON THE INSIDE WALL STOPPED UP THE AIR LEAKS BETWEEN LOGS.

LOG CABIN WALL
U.S. (1800's)



PLASTER ON STONE WALLS SEALED GAPS.

PENNSYLVANIA HOUSE (1800)

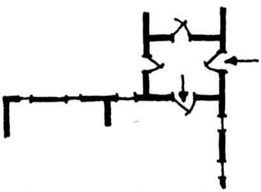
BRIEFLY HEATING AN IGLOO AFTER CONSTRUCTION FORMS AN ICE LAYER INSIDE THAT SEALS CRACKS.
SKINS HUNG INSIDE HELP INSULATE, TOO.

INUIT IGLOO, CANADA

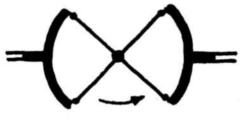
SIMPLE EXTERIOR SOLID SHUTTERS

NEW YORK (1706)

MANY IGLOOS HAVE THE ENTRANCE BELOW THE LIVING LEVEL SO THAT THE WARM AIR (WHICH RISES) DOES NOT ESCAPE.



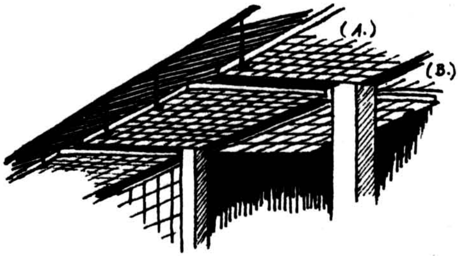
EARLY FARMHOUSES IN THE MIDWEST AND EASTERN U.S. HAD A "DOUBLE ENTRY" - THE ATTACHED SPACE ACTED AS A BUFFER TO PREVENT DIRECT LOSS OF HEAT.



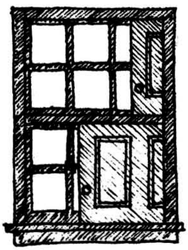
REVOLVING DOORS REDUCE HEAT LOSS BY ELIMINATING PATHS FOR DIRECT AIR FLOW BETWEEN INSIDE AND OUTSIDE.

Insulating the Openings

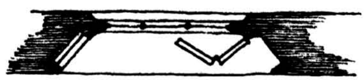
Exterior panel shutters, Virginia (1700's)



Futurasan Shrine, Nikko, Japan
The exterior shutters (A) here are solid for insulation while the interior ones (B) are translucent to admit natural light. Metal brackets from the ceiling hold them open.

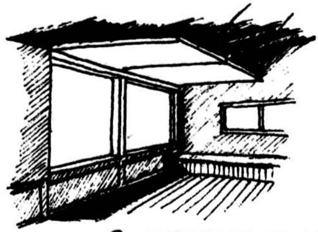


Sliding Indian Shutters
York, Maine (1800)



Bifold interior shutters
Philadelphia (1850)
These fold back neatly into the wall.

Icehouse window
Shaker Village,
Hancock, Massachusetts
Early use of multiple glazing to cut down heat flow



Contemporary house
Vermont
Panels are lowered over windows at night to reduce heat loss.

IN REVIEW, TO BEST RETAIN HEAT AND PROTECT AGAINST COLD, BUILDERS MUST:

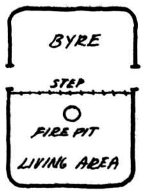
1) MINIMIZE THE STRUCTURE'S EXPOSURE TO THE COLD;
2) MINIMIZE THE HEAT LOSS FROM THE STRUCTURE BY USING VARIOUS INSULATING TECHNIQUES;
3) MAXIMIZE THE NATURAL HEAT GAINS FROM SUN AND EARTH.

AFTER THESE GUIDELINES HAVE BEEN FOLLOWED THERE MAY STILL BE A NEED FOR ADDITIONAL HEATING. THIS CAN BE SUPPLIED BY A VARIETY OF MEANS.

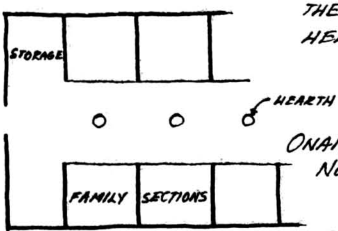
SOME ANTS HEAT THEIR COLONY BY TAKING TURNS SITTING OUT IN THE SUN SOAKING UP ITS RADIANT HEAT AND THEN GOING BACK INSIDE TO ACT AS LIVING PORTABLE HEATERS. WASPS AND BEES CAN HEAT THEIR HIVES WITH THE INCREASED BODY HEAT GENERATED THROUGH THE MUSCULAR EXERTION OF FLEXING THEIR ABDOMENS OR FLAPPING THEIR WINGS.

THE EARLY HUMAN SHELTERS RELIED PRIMARILY ON TWO HEAT SOURCES:

1) FIRE
2) BODY HEAT FROM PEOPLE AND ANIMALS



EUROPEAN LONGHOUSE (1100)
THE ANIMALS IN THE BYRE HELPED TO HEAT THIS PRIMITIVE SHELTER.



ONANDAGA LONGHOUSE
NORTH AMERICA, 15TH CENTURY

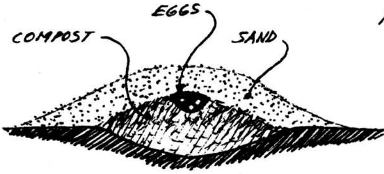
THE FIRES AND THE NUMEROUS OCCUPANTS COMBINED TO HEAT THESE LARGE (UP TO 125 FEET IN LENGTH) COMMUNAL DWELLINGS.

HEAT PRODUCTION OF AVERAGE PERSON:

SEATED	-	110 WATTS *
LIGHT WORK	-	170 WATTS
HEAVY WORK	-	440 WATTS

* FOR COMPARISON, A 100-WATT INCANDESCENT LIGHT PRODUCES APPROXIMATELY 96 WATTS OF HEAT.

THE BRUSH TURKEY BUILDS ITS BROODING MOUND BY GATHERING A LARGE PILE OF PLANT MATERIAL, PLACING THE EGGS ON TOP, AND COVERING THEM WITH SAND. THE FERMENTATION OF THE PLANTS GENERATES THE HEAT TO INCUBATE THE EGGS.

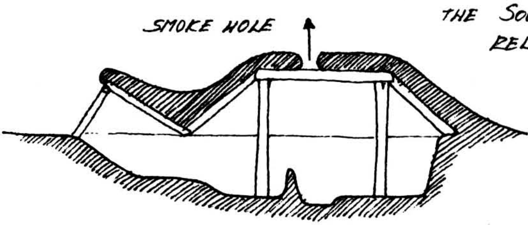


BRUSH TURKEY BROODING MOUND

A SINGLE WHALE OIL LAMP IN AN IGLOO CAN MAINTAIN A COMFORTABLE TEMPERATURE.

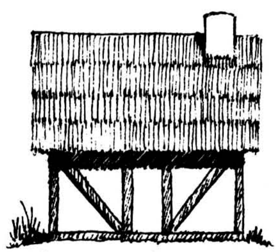
INUIT IGLOO, CANADA

EARLY INDIAN DWELLINGS IN THE SOUTHWESTERN U.S. RELIED UPON AN OPEN FIREPIT FOR HEAT WITH A SMOKE HOLE IN THE EARTH ROOF.



INDIAN DWELLING, AMERICAN SOUTHWEST (A.D. 500)

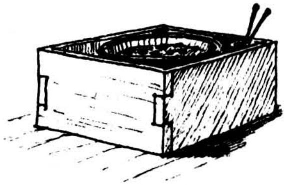
EARLY SETTLERS IN JAMESTOWN BUILT HUTS THAT HAD WALLS OF WATTLE (STICKS WITH INTERWOVEN TWIGS) AND DAUB (MUD), AND ROOFS OF THATCH. THE HOUSES HAD OPEN HEARTHS AND NO CHIMNEYS EXCEPT FOR THE SHORT OUTLET AT THE ROOF.



JAMESTOWN, VIRGINIA (CA. 1608)

THROUGHOUT HISTORY THE MOST COMMON FUEL USED FOR SPACE HEATING HAS BEEN WOOD.

JAPANESE RO

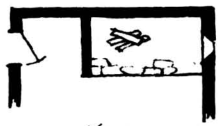


HIBACHI

FOR CENTURIES IN JAPAN WOOD HAS BEEN PROCESSED INTO CHARCOAL, WHICH IS THEN BURNED IN HEARTHS SET INTO THE FLOOR (ROS) OR IN PORTABLE HIBACHIS. CHARCOAL COMBUSTION YIELDS VERY LITTLE SMOKE, SO CHIMNEYS WERE NOT BUILT.

DUTCH HEARTH, 17th CENTURY

THE WIDE, DEEP HEARTH WITH ITS CANTILEVERED HOOD BROUGHT THE FIRE'S WARMTH RIGHT OUT INTO THE ROOM.

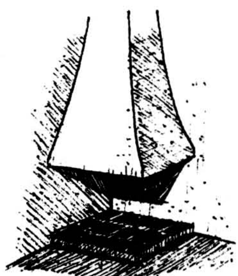


ENGLISH HEARTH
16th CENTURY

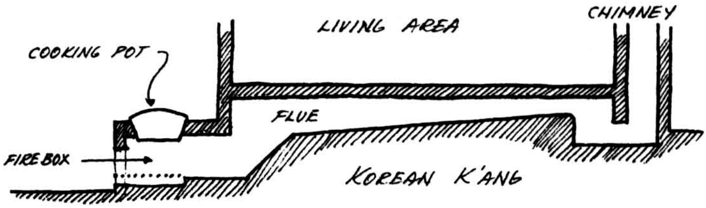
THE BIG HEARTH HAD SPACE ENOUGH FOR A NICE WARM WORK SPACE AND A WINDOW.

QUAKER FIREPLACES
19th CENTURY

THE CORNER FIREPLACE RADIATES HEAT WELL THROUGHOUT THE ROOM, AND THIS BACK-TO-BACK SCHEME ALLOWS TWO FIREPLACES TO SHARE ONE CHIMNEY, THEREBY REDUCING THE AMOUNT OF CONSTRUCTION THAT IS REQUIRED.

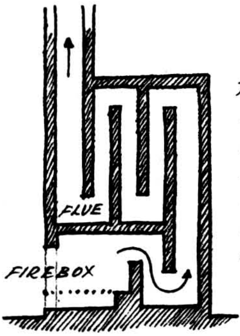


HOODED FIREPLACE WITH A BRICK HEARTH
NEW MEXICO (19th CENTURY)



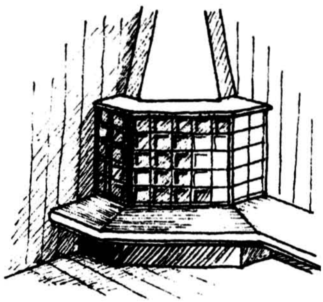
KOREAN K'ANG

IN THIS HEATING SYSTEM THE HOT GASES FROM THE FIRE WEAVE UNDER THE DWELLING FLOOR BEFORE GOING OUT THE CHIMNEY. THE ENTIRE FLOOR THEN ACTS AS A RADIANT HEATER. THE ROMANS USED A SIMILAR SYSTEM BUT WERE ABLE TO HEAT ALL SIX SURFACES SURROUNDING THE SPACE.



RUSSIAN STOVE

THE RUSSIAN MASONRY STOVE CONSISTS OF A SMALL FIREBOX AND A WINDING FLUE WITHIN A LARGE MASONRY MASS. THIS THERMAL MASS STORES THE HEAT AND GIVES IT UP SLOWLY. ONE SMALL FIRE PER DAY KEEPS THE HOUSE WARM.

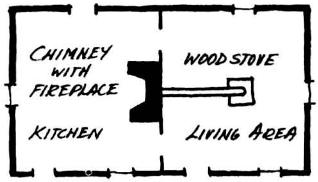


KACHELOFEN

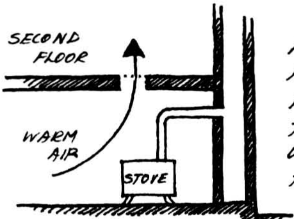
THE AUSTRIAN KACHELOFEN USES THERMAL MASS PRINCIPLES LIKE THE RUSSIAN STOVE AND IS USUALLY TILED. THE LOADING DOOR IS OFTEN BEHIND THE WALL IN AN ADJACENT ROOM OR HALLWAY.

IN THIS HOUSE IN BREWSTER, MASSACHUSETTS THE CHIMNEY IS CENTRALLY LOCATED SO IT CAN GIVE ITS HEAT TO THE INTERIOR SPACES RATHER THAN TO THE OUTDOORS.

THE INVENTION OF THE WOODSTOVE ALLOWED THE HEAT SOURCE TO BE MOVED OUT INTO THE ROOM. SUCH A CENTRAL LOCATION GAVE BALANCED RADIATION AND CONVECTION THROUGHOUT WHILE THE LONG RUN OF STOVEPIPE TO THE CHIMNEY SERVED AS AN ADDITIONAL RADIATOR OF HEAT THAT WAS PREVIOUSLY LOST UP THE CHIMNEY.



PLAN OF QUEBEC HOUSE

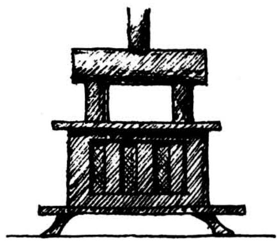


NEW ENGLAND FARMHOUSE

NATURAL CONVECTIVE CURRENTS RATHER THAN FANS WERE THE DRIVING FORCES BEHIND THE DISTRIBUTION OF THE WOODSTOVE'S HEAT. GRATES WERE USUALLY PLACED IN THE CEILING ABOVE THE STOVE TO ALLOW WARM AIR TO RISE TO THE SECOND FLOOR.

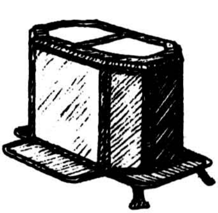
POTBELLY STOVE

THE SOMEWHAT SPHERICAL SHAPE OF THE OLD POTBELLY STOVE MADE IT A VERY EFFECTIVE RADIATOR.



IN ORDER TO YIELD AS MUCH HEAT AS POSSIBLE, MANY WOODSTOVE DESIGNS INCORPORATED LARGE HEAT EXCHANGERS TO EXTRACT HEAT FROM THE HOT FLUE PIPES.

VERMONT SOAPSTONE STOVE

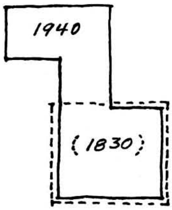


BECAUSE OF THEIR GREAT THERMAL MASS, SOAPSTONE STOVES HEAT UP AND COOL DOWN SLOWLY, WHICH RESULTS IN A RELATIVELY EVEN HEAT OVER A LONG PERIOD.

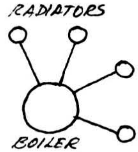
ANOTHER METHOD OF EFFECTIVELY DISTRIBUTING HEAT IS TO TRANSPORT THE HEAT SOURCE TO WHERE IT IS NEEDED.

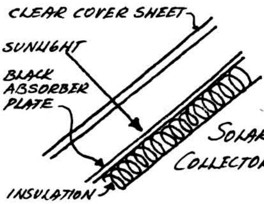
JAPANESE PORTABLE KEROSENE HEATER (USED NOW)

PORTABLE CHARCOAL BRAZIER USED IN OLYNTHUS, GREECE (400 B.C.)



CONTEMPORARY METHODS OF DISTRIBUTING HEAT WITH FANS AND PUMPS HAVE PERMITTED HOUSES TO BECOME SPREAD OUT AND FRAGMENTED. THIS RESULTS IN A SPATIAL CONFIGURATION THAT IS MUCH LESS EFFICIENT TO HEAT THAN THE OLD CENTRALIZED PLAN (SEE HOUSE PLAN TO THE LEFT).



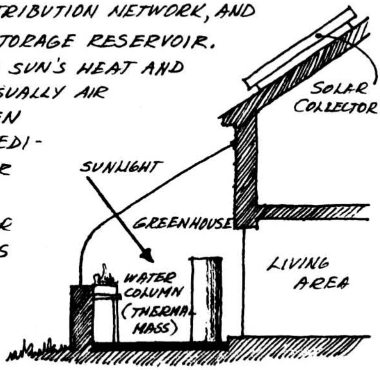


SOLAR COLLECTOR

ONE OF THE MOST RAPIDLY DEVELOPING HEATING TECHNOLOGIES IS SOLAR. A BASIC ACTIVE SOLAR SYSTEM CONSISTS OF A COLLECTOR, A DISTRIBUTION NETWORK, AND A HEAT STORAGE RESERVOIR.

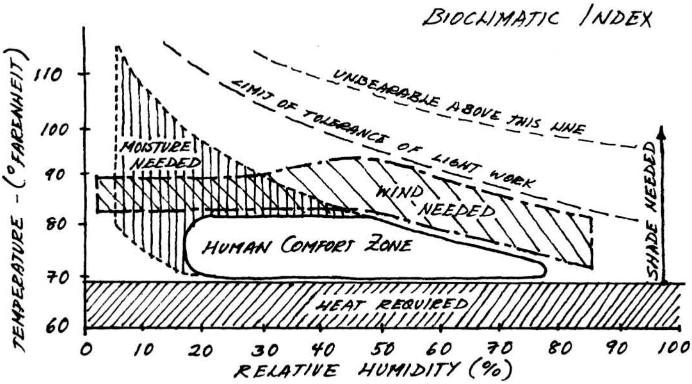
THE COLLECTOR ABSORBS THE SUN'S HEAT AND TRANSFERS IT TO A FLUID (USUALLY AIR OR WATER). THE HEAT IS THEN EITHER STORED OR USED IMMEDIATELY TO HEAT THE HOUSE OR THE DOMESTIC WATER.

MOST CONTEMPORARY SOLAR HOMES COMBINE ACTIVE SYSTEMS (THOSE NEEDING ENERGY INPUT) AND PASSIVE SYSTEMS SUCH AS ATTACHED GREENHOUSES, EXTRA SOUTH GLAZING, THERMAL MASS, AND MANY MORE.



CONTEMPORARY SOLAR HOUSE

STAYING COOL



THE ABOVE BIOCLIMATIC INDEX OUTLINES THE RELATIONSHIP BETWEEN TEMPERATURE, HUMIDITY, AND HUMAN COMFORT. WHEN CONDITIONS ARE ABOVE THE HUMAN COMFORT ZONE IT IS NECESSARY TO INTRODUCE A COOLING INFLUENCE SUCH AS SHADING, VENTILATION, OR ADDED MOISTURE.

THIS INFORMATION HAS MANY IMPORTANT HOUSING DESIGN IMPLICATIONS IN AREAS WHERE COOLING IS REQUIRED. THESE GUIDELINES VARY WITH THE CLIMATE:

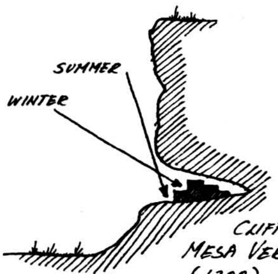
A) HOT-ARID CLIMATE: 1) TAKE ADVANTAGE OF THE BROAD DAILY TEMPERATURE VARIATION BY USING MATERIALS THAT ABSORB THE DAY'S HEAT FOR RERADIATION AT NIGHT AND BY TRAPPING AND HOLDING COOL NIGHT AIR, 2) GIVE PLENTY OF SHADING, AND 3) MINIMIZE DAYTIME VENTILATION

B) HOT-HUMID CLIMATE: 1) SITE, ORIENT, AND CONSTRUCT THE HOUSE TO TAKE MAXIMUM ADVANTAGE OF NATURAL VENTILATION, 2) USE POROUS NON-HEAT-ABSORBING MATERIALS, AND 3) SUPPLY ADEQUATE SHADING.

THE WAYS IN WHICH THE HUMAN BODY DISSIPATES HEAT:

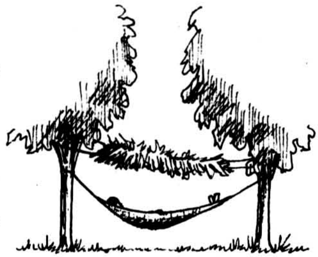
RADIATION	-	44 %
CONVECTION	-	32 %
EVAPORATION	-	21 %
CONDUCTION	-	3 %

FINDING COOL SITES



BEYOND THE ADVANTAGES PREVIOUSLY MENTIONED, THE CLIFFS AT MESA VERDE, COLORADO OFFERED SHADE FROM THE HOT SUMMER SUN BUT ADMITTED THE SUN'S NEEDED WARMTH IN WINTER.

CLIFF DWELLINGS
MESA VERDE, COLORADO
(1200)

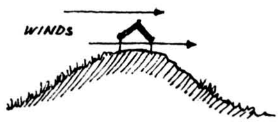


COLUMBIA

HERE, THE SHADE OFFERED BY TREES IS AUGMENTED BY A SUSPENDED, GRASS-COVERED NET TO SHIELD THE HAMMOCK.

NEW MEXICO

LOCATING DWELLINGS BY RIVERS OFFERS FRESH WATER AND TREES FOR SHADE, AND THE VALLEY TRAPS THE HEAVIER COOL AIR.



IN AREAS WHERE WIND IS THE PRIMARY COOLING AGENT, IT MAY BE ADVANTAGEOUS TO PUT THE HOUSE ON AN EXPOSED HILL.

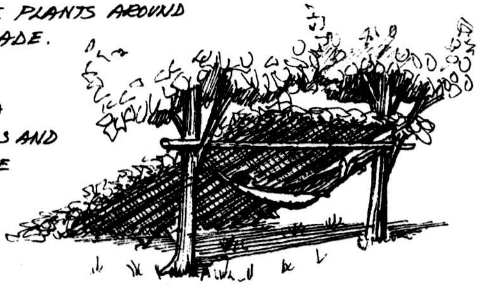
IN ADDITION TO SUPPLYING AN ALL-IMPORTANT SANCTUARY FROM CLOUDS OF MOSQUITOES, THESE HOUSES, PLACED IN TREES OUT IN THE WATER, WERE COOL RETREATS FROM THE TROPICAL HEAT.

ORINOCO DELTA, VENEZUELA (1600)

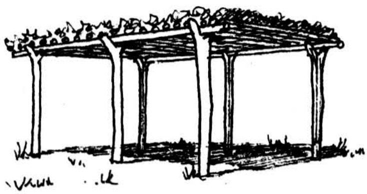
SHADING

EARLY MAN, LIKE THE APES, RELIED CHIEFLY UPON THE PLANTS AROUND HIM TO CREATE SHADE.

IN THIS CASE, A LEAN-TO OF BRANCHES AND LEAVES PROTECTS THE HAMMOCK OCCUPANT FROM RAIN AND SUN.

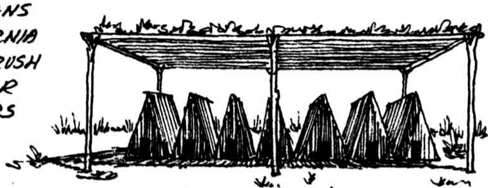


PRIMITIVE LEAN-TO



THE NAVAHO SUMMER SHELTER, OR RAMADA, HAS A SIMPLE POLE FRAME AND A ROOF OF POLES AND BRUSH. IT GIVES SHADE WHILE LETTING THE COOL BREEZES FLOW THROUGH.

THE YOKUT INDIANS OF SOUTHERN CALIFORNIA BUILT POLE AND BRUSH SHADE ROOFS OVER WHOLE GROUPS OF HUTS.

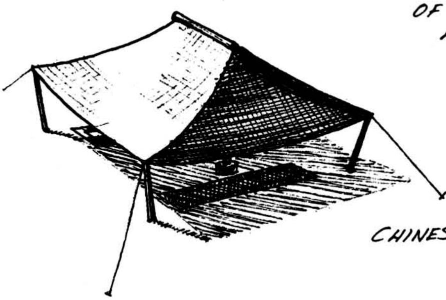


YOKUT TULE LODGE, CALIFORNIA

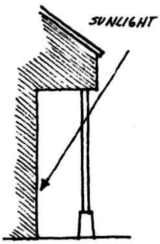
IN MANY WARM CLIMATES SHELTER TAKES THE FORM OF AN UMBRELLA TO PROTECT FROM THE RAIN AND TO GIVE SHADE FROM THE SUN.

SENUFO OUTDOOR KITCHEN, IVORY COAST

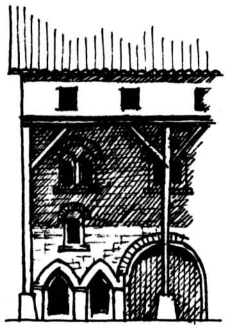
IN ASIA THE TENT HAS EVOLVED OVER THOUSANDS OF YEARS INTO A VERY HIGHLY DEVELOPED AND SOMETIMES ELABORATE SHELTER FROM SUN AND RAIN.



CHINESE MILITARY PAVILION



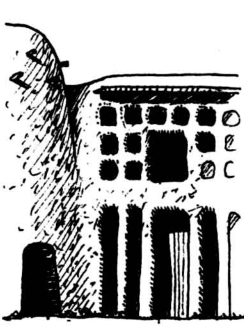
SOME BUILDINGS HAVE PROJECTING UPPER STORIES THAT, IN ADDITION TO ADDING MORE SPACE, CREATE A COVERED WALK BELOW AND SHADE MUCH OF THE LOWER RECESSED WALL.

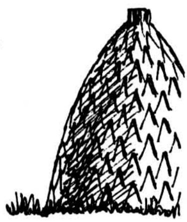


SECTION OF CASA ISOLANI

CASA ISOLANI, BOLOGNA, ITALY (1200)

ANOTHER WAY TO KEEP THE SUN FROM OVERHEATING A BUILDING IS TO CREATE A HIGHLY TEXTURED FACADE SO THAT THE PROTRUSIONS ACTUALLY SHADE THE REST OF THE WALL.





MOUSGOUM HOMESTEAD
NORTHERN CAMEROON

DOGON HOUSE
SANGA, MALI

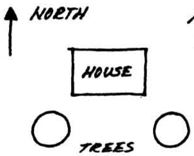
USING VEGETATION FOR SEASONAL SHADE

TRELLIS, OR PERGOLA, OVER DOORWAY

TRANI HOUSE
APULIA, ITALY

WIRE LATTICE USED AS A TRELLIS FOR VINES SHADING COURT

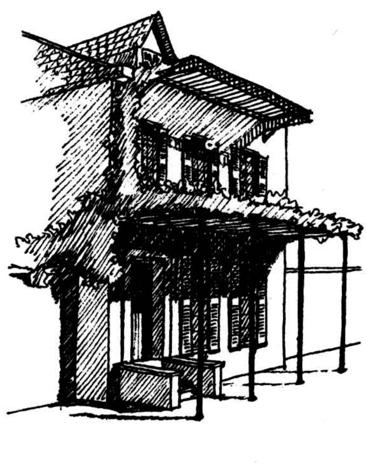
SHADED COURT, GRANADA, SPAIN



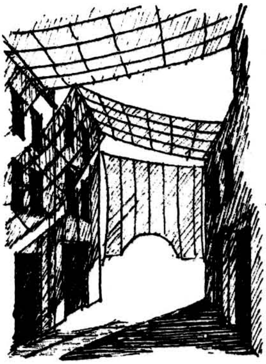
AN OLD NEW ENGLAND TRADITION IS TO PLANT HUSBAND AND WIFE TREES TO GIVE SUMMER SHADE TO THE HOUSE'S SOUTH SIDE WHEN IT IS MOST VULNERABLE IN THE MORNING AND EVENING.

FARMHOUSE
NEW HAMPSHIRE

IN MANY AREAS ELABORATE IRON GRILLWORK IS USED AS A LATTICE FOR VINES TO SHADE THE HOUSE.



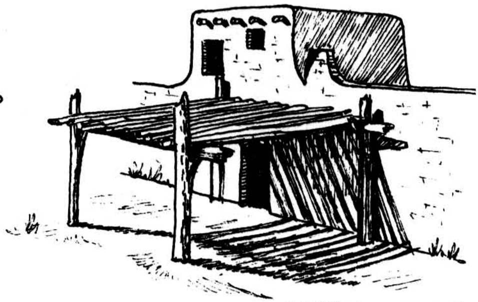
DOUBLE-TRELLISED HOUSE IN NEW ORLEANS, LOUISIANA



IN MOST WARM CLIMATES A GREAT DEAL OF THE ACTIVITY TAKES PLACE OUTSIDE. THE NEED TO SUPPLY SHADE IN OUTDOOR PUBLIC PLACES SPAWNED A WIDE VARIETY OF SHADES AND SUNSCREENS.

CANVAS AWNINGS, OR TOLDOS, UNFURLED BETWEEN BUILDINGS SEVILLE, SPAIN

RIGID FRAMES ROOFED WITH SPACED POLES ALSO SHADE STREETS AND WALKWAYS EFFECTIVELY.



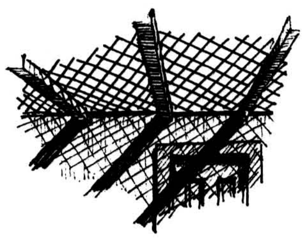
COVERED STREET
TAOS, NEW MEXICO

SIMPLE POLE-SUPPORTED AWNING

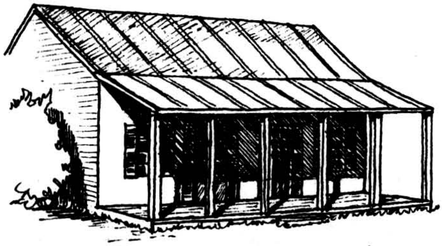
MYKONOS, GREECE

WOOD LATTICE SUNSCREEN

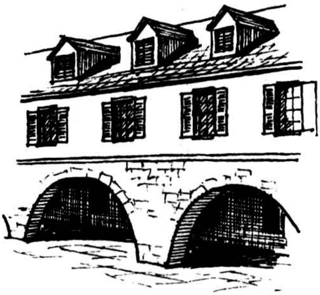
AFRICAN BAZAAR



COVERED PORCHES HAVE BEEN USED FOR THOUSANDS OF YEARS AS A SHADY SANCTUARY FROM THE HOT SUN.



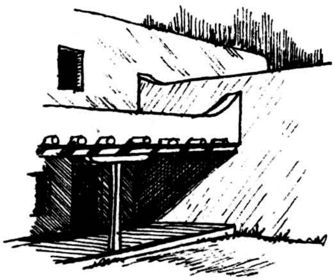
DOUBLE HOUSE
SAN ANTONIO, TEXAS



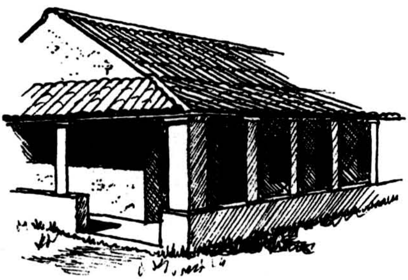
ARCADES CAN PROVIDE BOTH SHADE AND PROTECTION FROM RAIN AND SNOW.

DORDOGNE, FRANCE

PORCH ROOFS SUPPLY SHADE AND CAN ALSO BE USED AS ADDITIONAL LIVING OR SLEEPING AREAS.

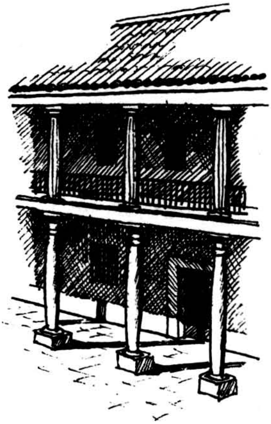


SANTA FE,
NEW MEXICO



SOME HOUSES HAVE PORCHES THAT WRAP ALMOST ENTIRELY AROUND THEM.

HACIENDA, VENEZUELA



THE RAISED BALCONY, OR LOGGIA, IS A VERY COMMON SIGHT IN WARM CLIMATES. THESE STRUCTURES CREATE RELATIVELY PRIVATE LIVING SPACES THAT ARE EXPOSED TO THE COOLING BREEZES. THEY ALSO CAN SHADE THE LOWER FLOOR.

LOGGIA, PEDRAZA, SPAIN

PROJECTING BALCONY
AFGHANISTAN

THIS LOGGIA IS PARTLY WINDOWED, PARTLY OPEN, AND PARTLY FITTED WITH LOUVERED SHUTTERS.

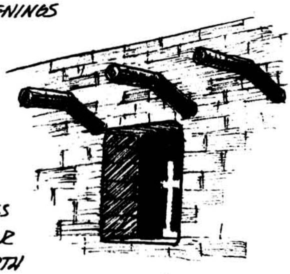
MYKONOS, GREECE

THIS LOGGIA FACES A SERENE, SHADED COURT AND ALSO SHELTERS THE PORCH BELOW, WHICH ACTS AS THE ENTRANCE.

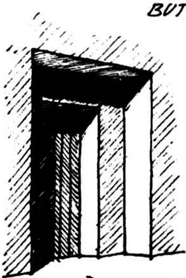
CHARLESTON,
SOUTH CAROLINA

SHADING THE OPENINGS

IN A WARM CLIMATE IT IS IMPORTANT TO DESIGN OPENINGS THAT ADMIT THE COOLING WINDS BUT NOT THE HEAT OF THE SUN. ONE WAY TO DO THIS IS TO RECESS THE WINDOW OR DOOR SO THAT THE DEPTH OF THE WALL SHADES MUCH OF THE OPENING.



PUEBLO WINDOW
NEW MEXICO



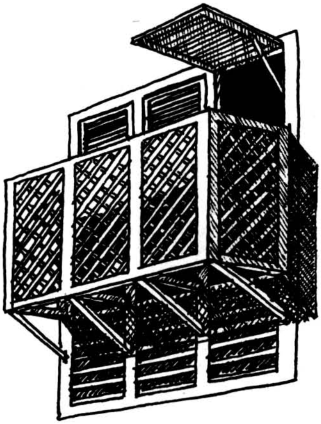
DOORWAY, AFGHANISTAN

AFGHAN WINDOW
MAYDAN VALLEY

SHADING DEVICES SUCH AS ROOFS, SHUTTERS, AWNINGS, LATTICES, AND LOUVERS ARE ALSO EFFECTIVE.

HORIZONTALLY HINGED SHUTTERS DOUBLE AS SHADES.
KAVALLA, GREECE

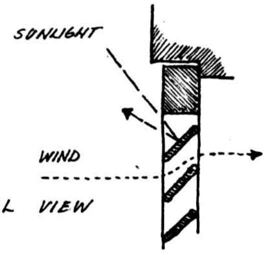
THIS WINDOW COMBINES SHUTTERS, LATTICE SCREENS, AND LOUVERS FOR GOOD VENTILATION AND PLENTY OF PRIVACY.



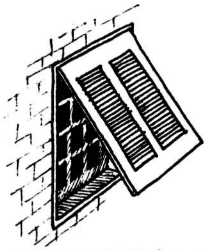
JEDDAH,
SAUDI ARABIA

FOR CENTURIES LOUVERED SHUTTERS HAVE BEEN USED AS A MEANS OF SHUTTING OUT THE HOT SUN BUT ALLOWING THE COOLING BREEZES TO FLOW THROUGH.

DOORWAY WITH
LOUVERED SHUTTER, FOSSACESIA, ITALY

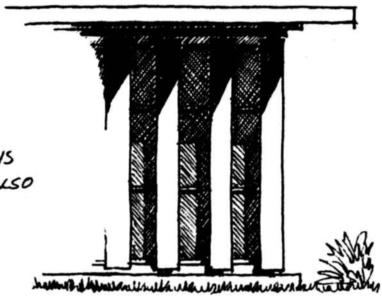


SECTIONAL VIEW



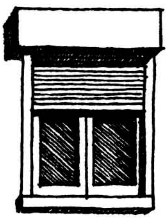
CONTEMPORARY LOUVERED
AWNING SHUTTER, FLORIDA

ADJUSTABLE, VERTICAL-AXIS LOUVERS, OR VANES, ARE ALSO VERY EFFECTIVE SHADING DEVICES.

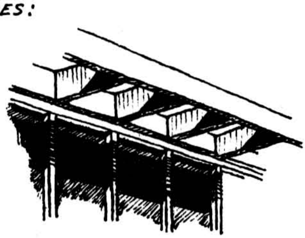


CONTEMPORARY HOUSE
RIO DE JANEIRO

OTHER SHADES:

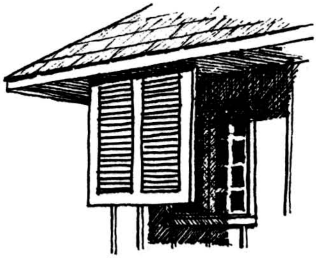


EXTERIOR, METAL
ROLL SHADE
LUXEMBOURG

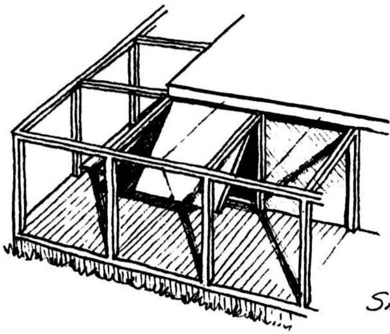


PROJECTING SUNSCREEN
NARA, JAPAN

PLACING THE SCREENS OR LOUVERED SHUTTERS AWAY FROM THE WINDOWS CAUSES LESS INTERFERENCE WITH THE AIR FLOW THROUGH THE HOUSE.

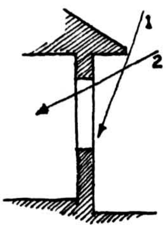


CONTEMPORARY HOUSE
SAN ANTONIO, TEXAS

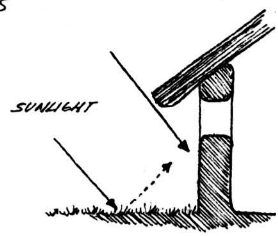


CONTEMPORARY HOUSE WITH PULLEY-OPERATED SHUTTER /SHADE PANELS

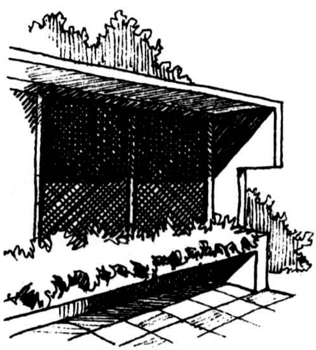
SANIBEL ISLAND,
FLORIDA



PROPERLY DESIGNED OVERHANGS CAN OFFER SHADE FROM THE HIGH SUMMER SUN (1) IN TEMPERATE AREAS AND ADMIT THE LOW WINTER SUN (2).



THE ROOF OF THIS AFRICAN HOUSE SHADES THE WINDOW, AND THE GRASS PATCH PREVENTS SUNLIGHT FROM BEING REFLECTED INSIDE.

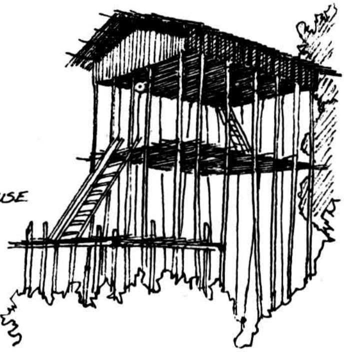


CONTEMPORARY OVERHANG
LOS ANGELES, CALIFORNIA

VENTILATION

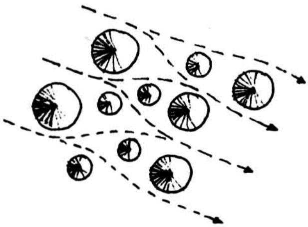
OPEN AND ELEVATED HOUSES ARE BUILT IN HOT, HUMID AREAS PARTLY BECAUSE THEY TAKE EXCELLENT ADVANTAGE OF THE COOLING BREEZES.

RAISED PLATFORM SEMINOLE BUILDING, FLORIDA



TREE HOUSE

NEW GUINEA

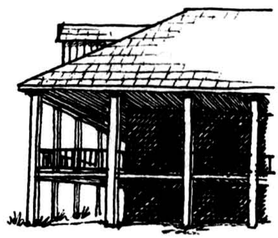


THE OPEN PLANNING OF VILLAGES IS ALSO ESSENTIAL FOR GOOD AIR FLOW.

AIR MOVEMENT THROUGH A BARI VILLAGE, SUDAN

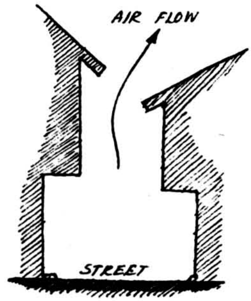
OPEN SAMOAN HUT

NOTE THE OPEN SECOND FLOOR IN THIS TWO-THOUSAND-YEAR-OLD CLAY MODEL OF A MINOAN HOUSE.



OPEN PORCH, NEW ORLEANS (1800's)

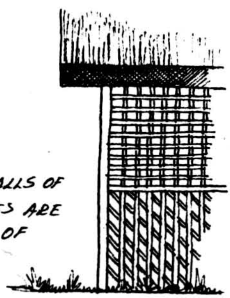
IN THE GREEK VILLAGE OF VERRIA HOMES FACING THE SAME STREET HAD ROOFS OF DIFFERENT HEIGHTS FOR ENOUGH SEPARATION TO ENSURE GOOD AIR FLOW.



VERRIA,
EARLY GREECE

FLAT TILES CAN BE ARRANGED IN SIMPLE PATTERNS TO CREATE GRILLES THAT ADMIT AIR BUT NOT SUNLIGHT.

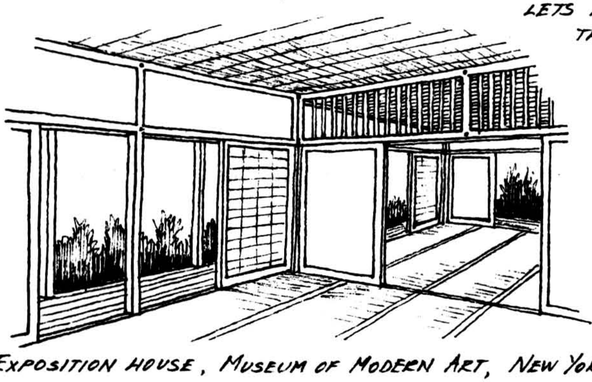
KSAR-EL-BARKA,
MAURITANIA



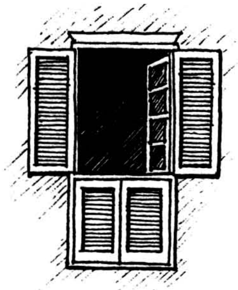
LATTICE WALLS OF REEDS AND POLES ARE USED IN MANY PARTS OF THE WORLD TO PERMIT VENTILATION.

SOUTHERN TANZANIA

THE OPEN PLAN OF JAPANESE HOUSES ALLOWS EXCELLENT VENTILATION. EVEN WITH THE SLIDING FUSUMAS CLOSED, THE LOUVERED TRANSOM ABOVE LETS AIR FLOW THROUGH.

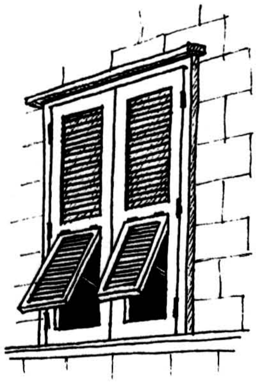


EXPOSITION HOUSE, MUSEUM OF MODERN ART, NEW YORK (1954)

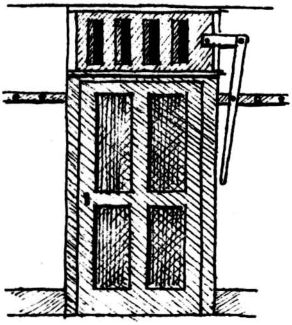


ONE OF THE MOST WIDELY EMPLOYED DEVICES THAT GIVES SHADE AND ALSO ALLOWS VENTILATION IS THE LOUVERED SHUTTER.

MULTIPLE SHUTTER, MACAO

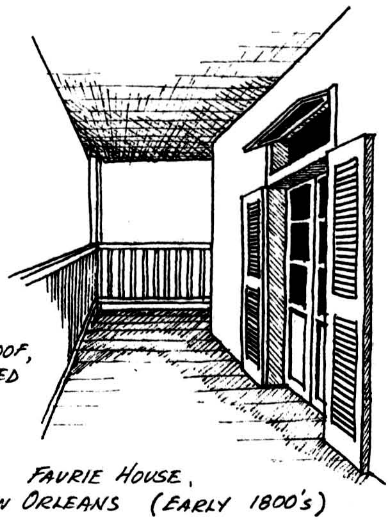


PORTISOL SHUTTER DUBROVNIK, YUGOSLAVIA



LEVER-OPERATED LOUVER PANEL TO OPEN OR CLOSE TRANSOM VENT

SHAKER DOOR HANCOCK, MASSACHUSETTS (1830)

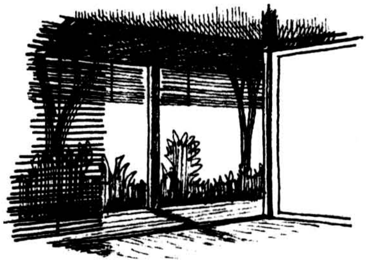


IN ADDITION TO BEING SHADED BY THE LOGGIA ROOF, THIS DOORWAY HAS LOUVERED SHUTTERS AND A GLASS TRANSOM VENT FOR GOOD AIR FLOW.

FAURIE HOUSE, NEW ORLEANS (EARLY 1800's)

THE HIGHLY DECORATIVE OPENINGS IN THIS SMITHY INSURE GOOD THROUGH-VENTILATION.

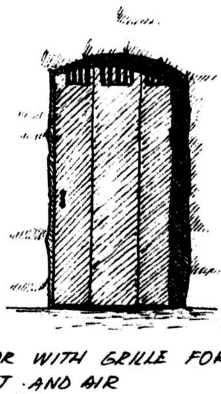
BIDA, CENTRAL NIGERIA



TRADITIONAL JAPANESE HOUSES ARE EQUIPPED WITH BAMBOO CURTAINS THAT SCREEN THE SUNLIGHT BUT LET AIR PASS THROUGH.

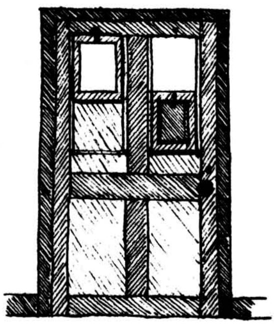
NUMAZU, JAPAN

STONE VENTILATION GRILLE GUANAJUATO, MEXICO



DOOR WITH GRILLE FOR LIGHT AND AIR VERACRUZ, MEXICO

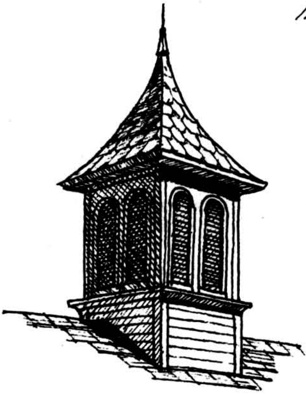
THIS DOOR HAS TWO SMALL, GLAZED SASHES THAT CAN SLIDE DOWN TO MAKE OPENINGS FOR VENTILATION.



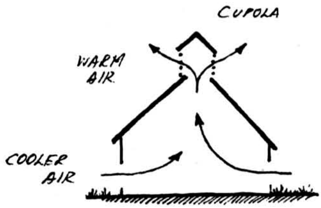
SHAKER DOOR CANTERBURY, NEW HAMPSHIRE (1831)

INDUCED VENTILATION

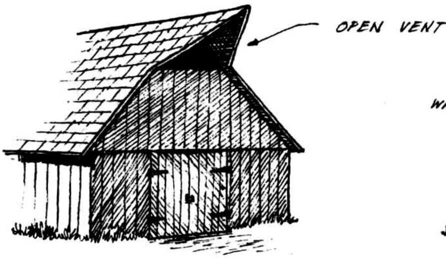
THE NATURAL TENDENCY OF WARMER AIR TO RISE CAN BE USED AS THE DRIVING FORCE TO VENTILATE BUILDINGS. THE VENTING OF WARM AIR AT THE TOP WILL DRAW COOLER AIR IN AT THE BOTTOM.

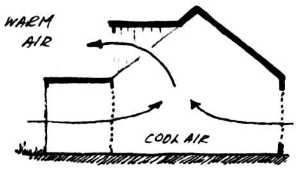


CUPOLA ON A NEW HAMPSHIRE BARN

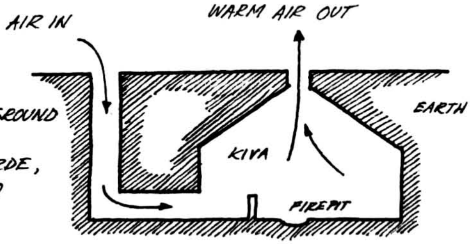


BARN AIR FLOW





AMERICAN TOP HAT BARN



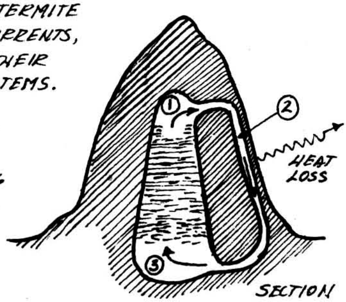
SECTION THROUGH CEREMONIAL UNDERGROUND KIVA

MESA VERDE, COLORADO

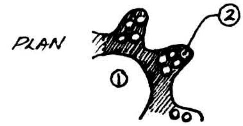
WARM AIR RISING OUT DRAWS OUTSIDE AIR THROUGH AN UNDERGROUND CHANNEL WHERE IT IS COOLED BEFORE IT ENTERS THE KIVA.

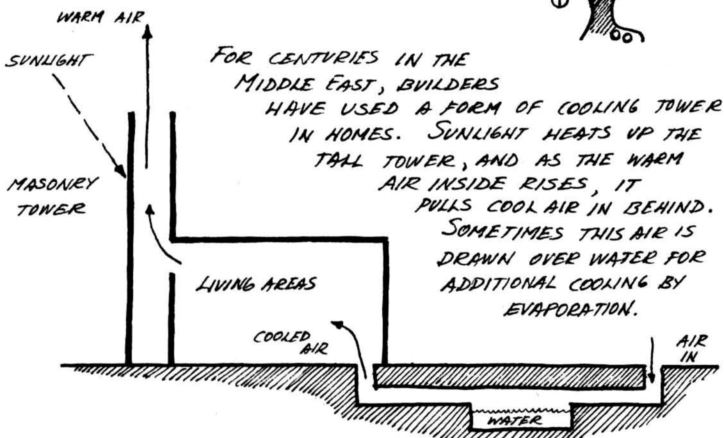
FOR MILLIONS OF YEARS, TERMITE COLONIES HAVE USED THERMAL CURRENTS, OR THERMOSIPHONING, TO DRIVE THEIR COOLING AND AIR PURIFICATION SYSTEMS.

AIR HEATED BY THE COLONY RISES TO THE TOP (1) AND THEN FLOWS INTO THE TRANSPIRATION TUBES (2), WHICH ACT LIKE COOLING FINS. AS THE AIR IS COOLED, IT SINKS TO THE BOTTOM OF THE COLONY (3), AND THE CYCLE CONTINUES. FRESH AIR IS ALSO ABSORBED THROUGH THE THIN WALLS OF THE TUBES.

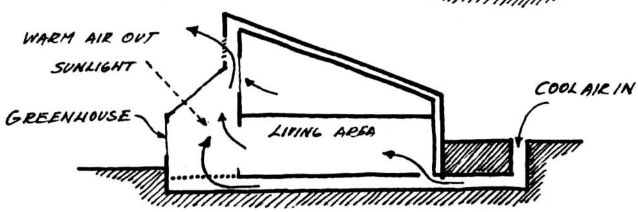


TERMITE MOUND





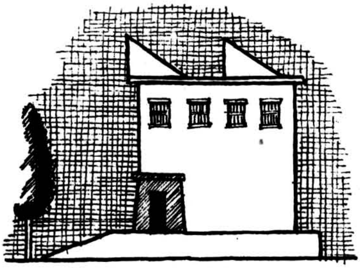
FOR CENTURIES IN THE MIDDLE EAST, BUILDERS HAVE USED A FORM OF COOLING TOWER IN HOMES. SUNLIGHT HEATS UP THE TALL TOWER, AND AS THE WARM AIR INSIDE RISES, IT PULLS COOL AIR IN BEHIND. SOMETIMES THIS AIR IS DRAWN OVER WATER FOR ADDITIONAL COOLING BY EVAPORATION.



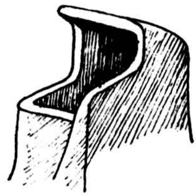
IN THIS CONTEMPORARY SOLAR HOUSE, THE HEAT GENERATED BY SUNLIGHT IN THE GREENHOUSE CAUSES THE AIR TO RISE AND ESCAPE, AND AS IT DOES IT PULLS COOL AIR INTO THE LIVING AREAS.

CHANNELING THE WIND

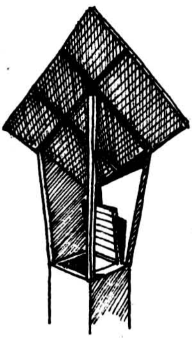
DEVICES THAT COOL HOUSES BY DIRECTING THE WIND INSIDE HAVE BEEN USED FOR CENTURIES.



EGYPTIAN HOUSE WITH WIND SCOOPS
MIDDLE KINGDOM



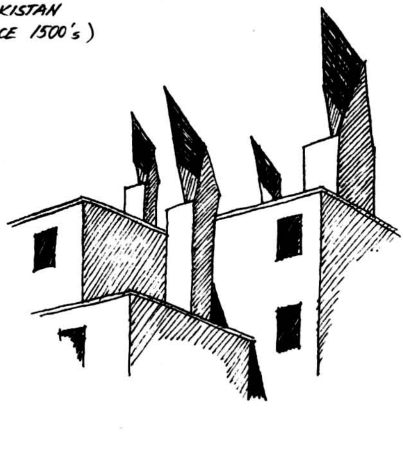
PERUVIAN WIND SCOOP
(PRE - A.D. 700)



WIND SCOOP WITH TRAP DOOR
WEST PAKISTAN
(USED SINCE 1500's)

ROOFSCAPE
WITH WIND SCOOPS

SIND DISTRICT,
WEST PAKISTAN

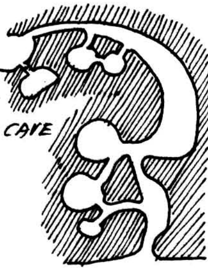


WIND SCOOPS
ON ROOFTOPS

HERAT, AFGHANISTAN

THERMAL MASS

AS THE GRAPH ON PAGE 33 SHOWS, THE PROPER USE OF HEAT-ABSORBING, OR THERMAL MASS, MATERIALS IN HOT, ARID CLIMATES CAN HEAT A HOUSE DURING THE NIGHT AND COOL IT DURING THE DAY. THE EARTH IS SUCH A LARGE MASS THAT ITS TEMPERATURE STAYS RELATIVELY CONSTANT YEAR-ROUND AND CAN HELP WARM A HOUSE IN THE WINTER AND COOL IT IN THE SUMMER.

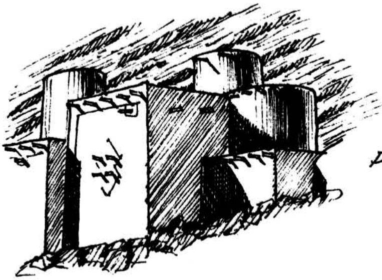


PARTIAL PLAN OF ROMAN SUMMER CAVE

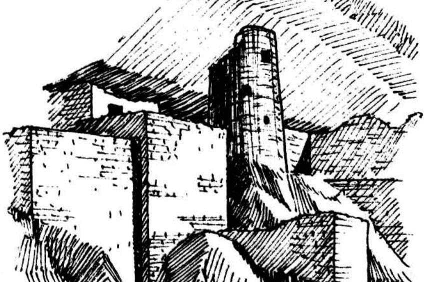
OTHER SOLID MATERIALS PROVIDE THERMAL MASS:

BADAKSHAN DOMED, MUD HOUSE, AFGHANISTAN

MATAKAM HOUSE
CAMEROON



MUD AND STONE DOGON CLIFF DWELLINGS, MALI



STONE
CLIFF DWELLINGS
MESA VERDE,
COLORADO

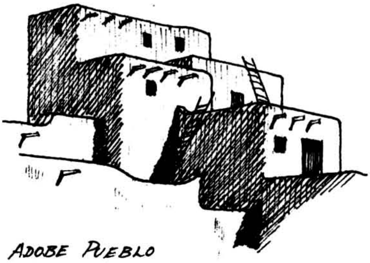
(1200)

THIS HOUSE CONSISTS OF FIVE HUTS WITH THICK ADOBE WALLS GROUPED TO FORM A CENTRAL COURT, WHICH IS SHADED BY A TRELLIS.

MESAKIN QUISAR CLUSTER DWELLING
SUDAN

THE GROUPING OF MANY DWELLINGS IN A SINGLE, SOLID STRUCTURE PROVIDES A LARGE THERMAL MASS AND ALSO LEAVES A MINIMUM OF SURFACE EXPOSED TO THE HEAT.

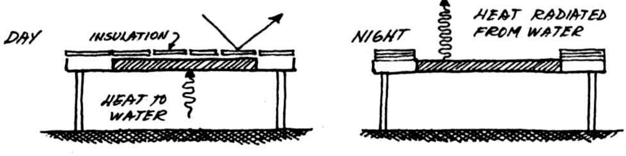
DAMMUSO HOUSE
PANTELLERIA, ITALY



ADOBE PUEBLO
TAOS, NEW MEXICO

VAULTED HOUSES
GREECE

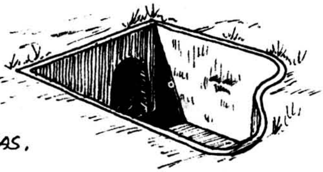
ROOF POND COOLING



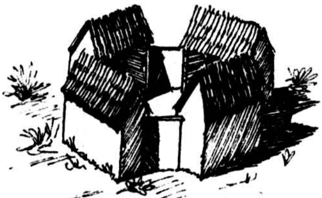
THIS CONTEMPORARY COOLING SYSTEM USES A POND OF WATER AS A HEAT SINK ON THE ROOF. INSULATED FROM THE SUN DURING THE DAY, THE POND ABSORBS HEAT FROM THE HOUSE. UNCOVERED AT NIGHT, IT CAN LOSE ITS HEAT TO THE SKY.

USING COURTYARDS TO TRAP COOL AIR

THE TENDENCY OF COOLER AIR TO SINK PERMITS AN ENCLOSED COURT TO EFFECTIVELY TRAP THE COOL NIGHT AIR IN HOT, ARID AREAS.



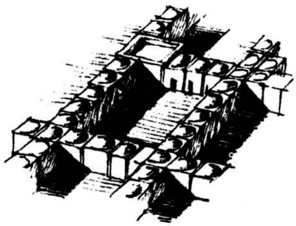
COURT OF SUBTERRANEAN DWELLING, TUNISIA



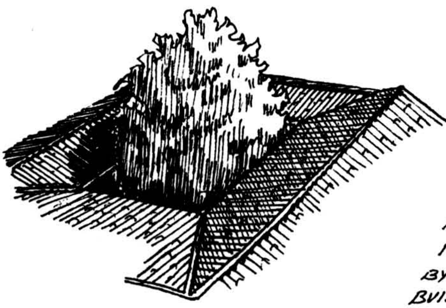
ASHANTI HOUSE, GHANA

THIS AFRICAN HOUSE HAS AN ENCLOSED COURTYARD, OR "GYAASE," TO GIVE SHADE AND PRIVACY AND TO HOLD COOL AIR.

IN MANY AREAS, A NUMBER OF DWELLINGS ARE BUILT AROUND A CENTRAL COURT, WHICH BECOMES A SANCTUARY FROM THE HEAT.



EL OUED, ALGERIA

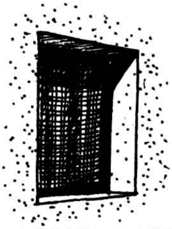


TREE IN ENCLOSED COURTYARD VENEZUELA

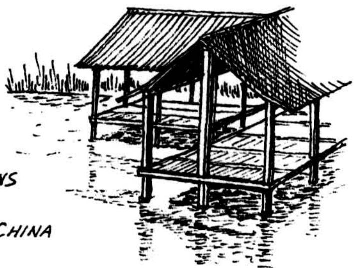
THE COURTYARD IS KEPT MUCH COOLER IF IT IS FULLY SHADED BY EITHER THE SURROUNDING BUILDINGS (SEE ABOVE), BY VINES (SEE PAGE 49), OR BY TREES.

EVAPORATIVE COOLING

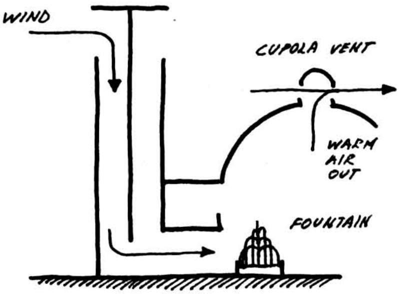
WATER WILL EVAPORATE AS IT ABSORBS HEAT FROM THE SURROUNDING AIR. THIS PROCESS, WHICH RESULTS IN THE AIR BEING COOLED, CAN BE USED TO HELP COOL HOUSES IN ARID CLIMATES.



A WATER-SOAKED CLOTH IN THE WINDOW COOLS THE INCOMING AIR.
INDIA



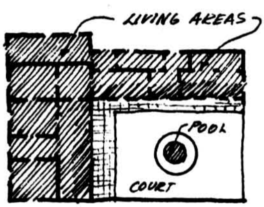
DINING PAVILIONS BUILT OVER WATER
CHINA



YAZD, IRAN (1400)

IN IRAN SOME BUILDINGS HAVE TOWERS TO CATCH THE WIND AND DIRECT IT INSIDE, WHERE IT IS COOLED AS IT PASSES BY A FOUNTAIN OR POOL. THE WIND ALSO HELPS TO DRAW THE WARM AIR OUT AT THE CUPOLA (SEE PAGE 60).

A FOUNTAIN OR POOL IN A COURTYARD WILL HELP COOL THE AIR, AND THE ENCLOSURE WILL PREVENT THE LOSS OF THAT COOL AIR.

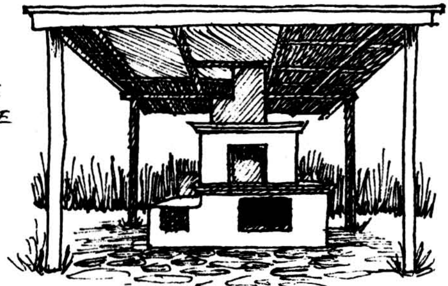


PLAN OF HOUSE WITH COURT AND POOL, VENEZUELA

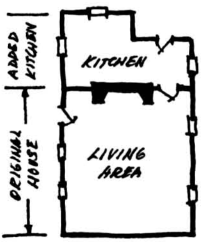
REMOVING HEAT SOURCES

ONE VERY SIMPLE WAY TO COOL A HOME IS NOT TO HEAT IT. THIS MEANS TRYING TO REMOVE THE THERMAL IMPACT OF SUCH PRIMARY FUNCTIONS AS COOKING AND BATHING.

FOR CENTURIES ONE APPROACH HAS BEEN TO REMOVE THE COOKING WORK FROM THE HOUSE AND TO CREATE A SEPARATE SUMMER KITCHEN.



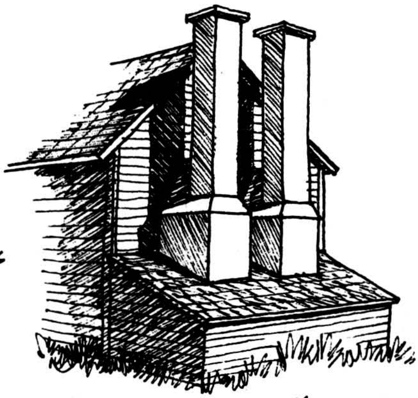
SUMMER KITCHEN, CURJENI, RUMANIA



HERE, THE KITCHEN IS ATTACHED BUT NOT WITHIN THE LIVING AREA OF THE HOUSE.

PLAN OF A FARMHOUSE IN PENNSYLVANIA (1709)

CHIMNEYS ARE MAJOR HEAT SOURCES. SEPARATING THEM FROM THE HOUSE LESSENS THEIR EFFECT AND ALSO REDUCES THE FIRE HAZARD.



PARISH MANSION, VIRGINIA

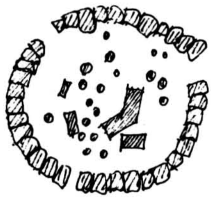
TO HELP COOL HOMES TODAY, THE HEAT PRODUCED BY APPLIANCES SUCH AS STOVES, REFRIGERATORS, CLOTHES DRYERS, AND WATER HEATERS SHOULD BE KEPT AWAY FROM THE LIVING AREAS.

Staying Healthy

People have always had to defend themselves against the environment. Their shelters quickly became their primary defense. It gave refuge from pests, predators, and humans.

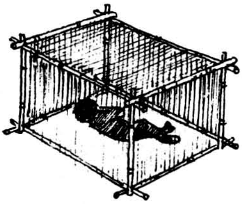
This tree dwelling provides an escape from the leeches on the wet ground.

Sakai tree house, Malaya



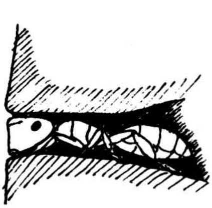
Grouping dwellings in protective circles is another way of gaining security and privacy.

Plan of Garunsi Compound
Upper Volta



This Japanese portable frame with mosquito netting protects infants very effectively.

In the Alps, most of the food storage buildings are raised on piers incorporating flat rocks as rodent guards.

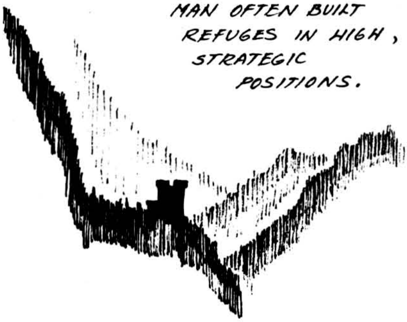


Some species of ant have special doorkeepers with enlarged heads. They plug the entrances and admit only the residents, who know the proper antenna tap code.

THE EAGLE USES ITS AERIE AS A SECURE REFUGE FROM PREDATORS AND AS AN OBSERVATION POST FROM WHICH TO KEEP A SHARP EYE ON ITS DOMAIN.

EAGLE'S AERIE

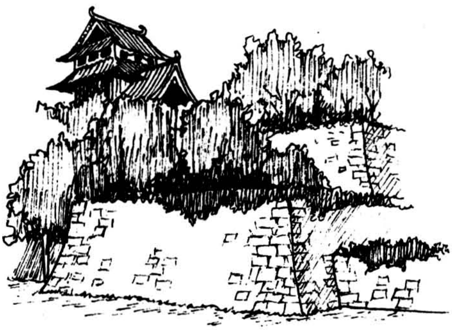
LIKE THE EAGLE, MAN OFTEN BUILT REFUGES IN HIGH, STRATEGIC POSITIONS.



THE ANASAZI INDIANS OF THE AMERICAN SOUTHWEST USED LOFTY CRAGS IN SHEER CLIFFS AS DEFENSIVE POSITIONS AND LOOKOUTS, WHILE THE RIVER PLAIN WAS LEFT OPEN FOR AGRICULTURE.

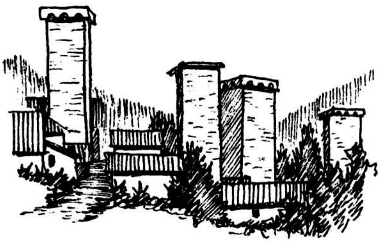
THE WHITE HOUSE
CANYON DE CHELLY
ARIZONA

WHEN LACKING A LOFTY SITE FOR A BASTION, THE NEXT BEST THING WAS TO CREATE A HILL, USUALLY WITH TIERED, FORMIDABLE WALLS.



KUMAMOTO CASTLE, JAPAN

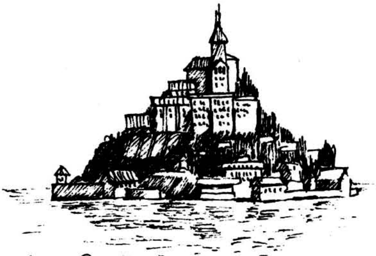
IN MEDIEVAL EUROPE THERE WAS A PRONOUNCED NEED FOR FORTIFICATIONS. IN SOME VILLAGES, DEFENSIVE TOWERS BECAME A DOMINANT ARCHITECTURAL FEATURE.



VILLAGE IN THE CAUCASUS
U.S.S.R.

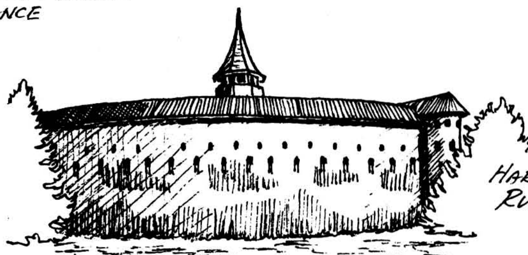
A MAZE OF NARROW, WINDING STREETS WOULD MAKE ANYONE ATTACKING VERY VULNERABLE AS THEY MOVED THROUGH THE CITY.

SAN GIMIGNANO, ITALY



MONT-SAINT MICHEL
FRANCE

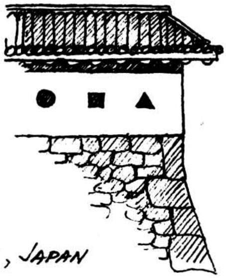
LIMITED ACCESS AND NARROW, WINDING STREETS GAVE MT.-ST. MICHEL A STRONG DEFENSE.

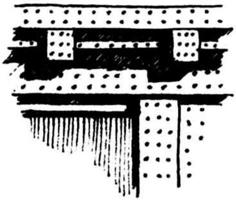


HARMAN,
RUMANIA

SOME ENTIRE VILLAGES BECAME WALLED FORTRESSES.

THE USE OF MORE DURABLE MATERIALS IS A VERY IMPORTANT PART OF A STRONG DEFENSE. IN THIS CASTLE WALL, FOR INSTANCE, THE RESISTANCE TO FIRE IS INCREASED WITH THE USE OF TILE, PLASTER, AND STONE.

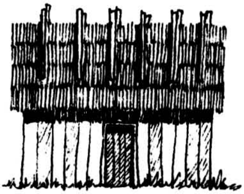




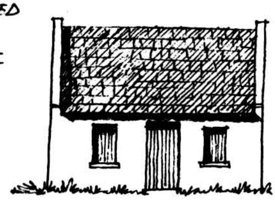
HIMEJI CASTLE, JAPAN

IN THE SAME CASTLE, SOME OF THE DOORWAYS ARE METAL-CLAD AND THUS IMPREGNABLE.

IN 1702 THE TINDER-LIKE THATCH AND BOARD HOUSES IN THE SPANISH SETTLEMENT OF ST. AUGUSTINE WERE BURNED TO THE GROUND BY CAROLINA COLONISTS. IN REBUILDING THE TOWN, TABBY, A MIXTURE OF LIME MORTAR AND SHELLS, WAS USED TO MAKE THE BUILDINGS MORE RESISTANT TO FIRE.



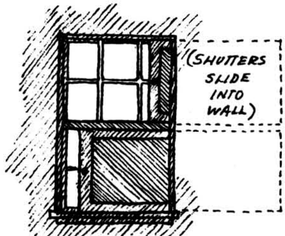
THATCH AND BOARD HOUSE, ST. AUGUSTINE, FLORIDA (1700)



TABBY AND SHINGLE HOUSE ST. AUGUSTINE, FLORIDA (1710)

PROTECTING THE WINDOWS:

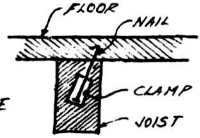
SOLID EXTERIOR SHUTTER PENNSYLVANIA



SLIDING INDIAN SHUTTERS NEW HAMPSHIRE

Protecting Against Intruders

This ingenious floor has special clamps in which the flooring nails can slide, producing a chirping sound. Anyone walking on the floor would cause the chirping and thus no one could sneak up on the emporer.

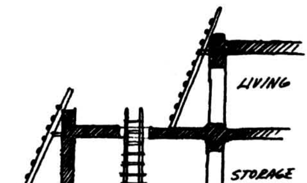


Nightingale Floor
Nijo Castle, Japan

One of the best security measures is to design the entrance to a dwelling so that anyone coming in is practically defenseless. Many African dwellings' doorways have high thresholds and low lintels, which force people to bow as they enter. This puts them in a vulnerable position.

Another effective way to limit access is to remove the means. This drawbridge can be withdrawn into the castle.

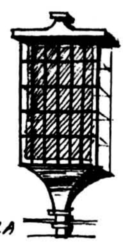
Rothesay Castle
Scotland (1312)



Early pueblo dwellings had ladders through the roof for access. The ladder could be drawn up for security. Entering by descending a ladder also made an intruder very vulnerable.

Section through
Acoma Pueblo, New Mexico (A.D. 900)

Metal door and window grilles can bar access but still admit light and air.

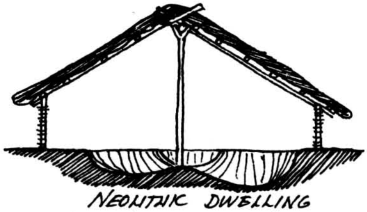


Window grille, Venezuela

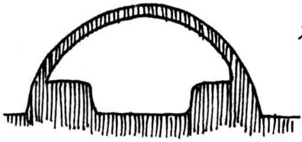
SECTION II - ACCOMMODATION OF HUMAN NEEDS

SLEEPING

DUE TO POOR NIGHT VISION, PEOPLE ARE VERY VULNERABLE CREATURES IN THE DARK, SO EARLY SHELTERS WERE SIMPLY PROTECTED PLACES IN WHICH TO SLEEP. VERY SOON, THOUGH, BUILDERS WENT BEYOND CRUDE SHELTER AND BEGAN TO PAY ATTENTION TO COMFORT.



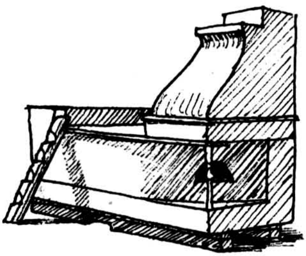
NEOLITHIC DWELLING
KÖLN LINDENTHAL, GERMANY
THE EARTH FLOOR WAS SCULPTED TO CREATE SEATS, BEDS, ETC.



INUIT IGLOO, CANADA

THE AIR AT THE TOP OF A SPACE IS WARMER (WARM AIR RISES), SO SLEEPING SHELVES IN IGLOOS ARE BUILT UP OFF THE FLOOR.

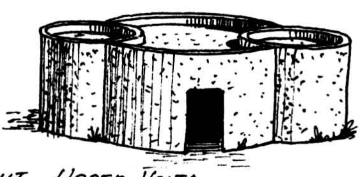
IN SOME JAPANESE HOMES A PIT, OR RO, CONTAINING HOT COALS IS COVERED BY A WOODEN FRAME AND IS USED TO PREHEAT THE BEDDING, OR FUTON.



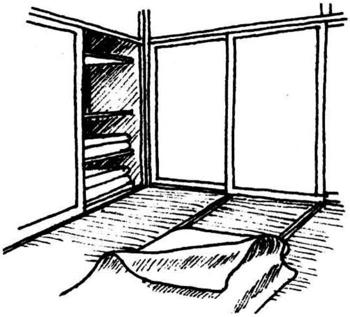
SOME MASONRY STOVES HAVE BUILT-IN PLATFORMS THAT CAN BE USED AS COZY SLEEPING SHELVES.

TRADITIONAL FINNISH STOVE WITH GRANDMOTHER SHELF.

IN OTHER AREAS STAYING COOL IS A PRIMARY GOAL, AND OFTEN THE ROOF BECOMES A COOL AND SAFE SLEEPING LOFT.

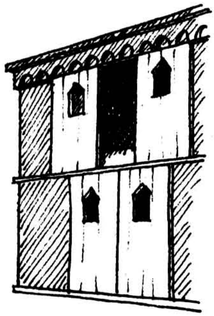


GARUNSI HUT, UPPER VOLTA



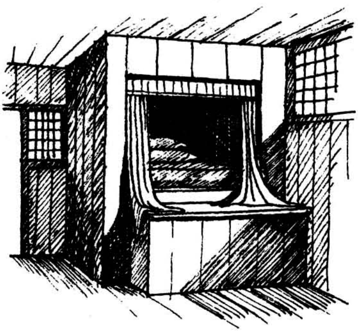
IN JAPAN THE BEDDING, OR FUTON, IS STORED IN A CLOSET, OR "OSHIIRE," AND BROUGHT OUT AS NEEDED AT NIGHT. THIS SAVES SPACE, BECAUSE DURING THE DAY NO ROOM IS JUST AN UNUSED BEDROOM, AND AT NIGHT ANY ROOM CAN BECOME A BEDROOM.

CLOSET ("OSHIIRE") FOR STORING FUTONS
JAPAN



OVER THE CENTURIES PEOPLE HAVE DEVISED MANY INGENIOUS WAYS TO SECRETE BEDS FOR PRIVACY, SECURITY, OR JUST AESTHETICS.

TWO-TIERED BRETON CUPBOARD BED WITH SLIDING DOORS.



PARTITIONED AND CURTAINED BED ALCOVE.

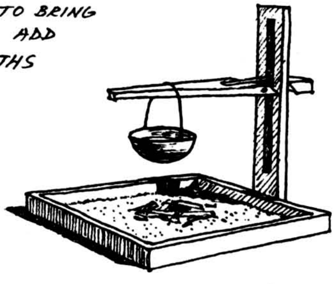
HOLLAND, 17th CENTURY

THE TWO SMALL LEAN-TOS AT EITHER SIDE OF THIS HOUSE WERE ADDED AS EXTRA SLEEPING SPACES.

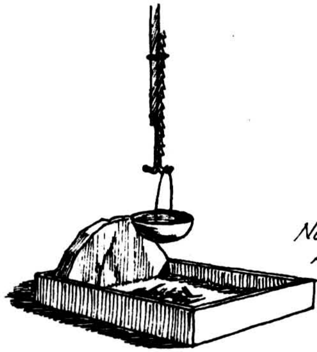
NANTUCKET WHALER'S HOUSE, 18th CENTURY

COOKING

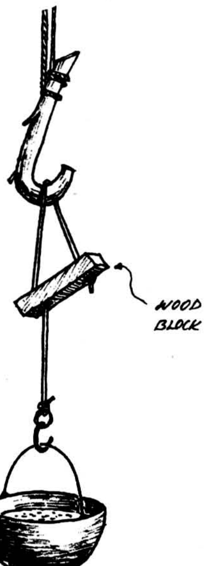
EARLY SHELTERS WERE SIMPLY FOR SLEEPING, BUT IN COOLER CLIMATES THERE WAS A NEED TO BRING THE FIRE INSIDE TO COOK AND ADD WARMTH. THE EARLIEST HEARTHS CONSISTED OF SIMPLE OPEN FIREPITS, FROM WHICH THE FIREPLACE EVOLVED.



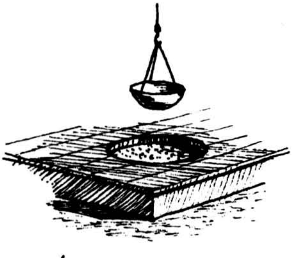
EARLY JAPANESE SAND HEARTH WITH KETTLE ARM



NORWEGIAN FIREPLACE WITH ADJUSTABLE KETTLE HOLDER

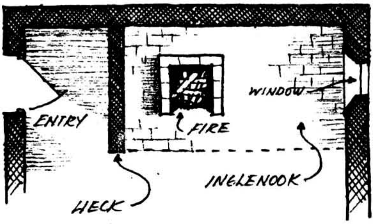


JAPANESE KETTLE HOLDER (THE WOOD BLOCK ON THE ROPE LOCKS THE WEIGHT ADJUSTMENT)



JAPANESE CHARCOAL FIREPLACE

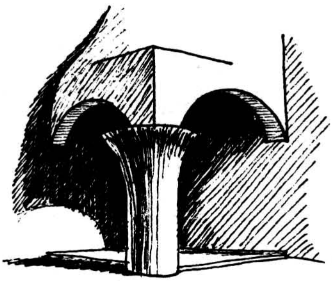
AS THE FIREPLACE BECAME INTEGRATED INTO THE STRUCTURE OF THE HOUSE A HOOD WAS BUILT TO CAPTURE THE SMOKE, AND THE FIREPLACE GREW INTO A DOMINANT CENTRAL ELEMENT.



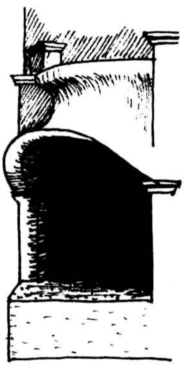
PLAN OF AN ENGLISH FIREPLACE (1500'S)

THE HOOD OVER THIS FIRE-PLACE COVERS BOTH THE FIRE AND AN INGLENOOK, WHICH HAS A SMALL WINDOW. ONE SIDE OF THE HOOD IS SUPPORTED BY A SHORT WALL CALLED A HECK, WHICH ALSO BUFFERS THE ENTRY.

THIS CORNER FIREPLACE HAS A HOOD OF WATTLE AND DAUB (SEE PAGE 121) SUPPORTED BY A LINTEL THAT WAS MADE FROM THE CROOK OF A TREE.



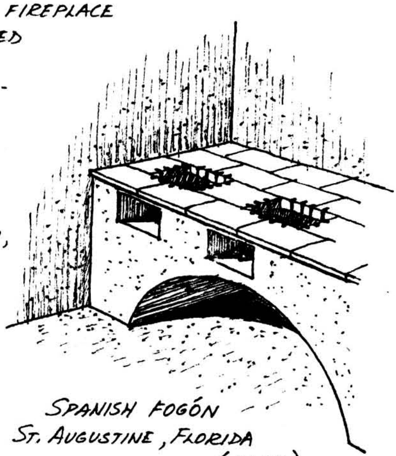
DOUBLE-ARCHED, MASSIVE CORNER FIREPLACE
TAOS, NEW MEXICO (1834)



ARCHED HOOD
LIVING ROOM FIREPLACE, COPENHAGEN

GRADUALLY THE OPEN FIREPLACE EVOLVED INTO AN ENCLOSED FIREBOX THAT WAS MUCH MORE EFFICIENT AT TRANSFERRING HEAT TO THE COOKING VESSELS.

THE SPANISH MASONRY STOVE, OR FOGÓN, HAS SEVERAL SMALL FIREBOXES UNDER A TILE COOKING SURFACE.

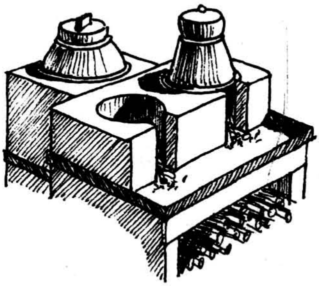


SPANISH FOGÓN
ST. AUGUSTINE, FLORIDA
(1787)

A HOOD TO CARRY OFF THE SMOKE WAS A WELCOME ADDITION.

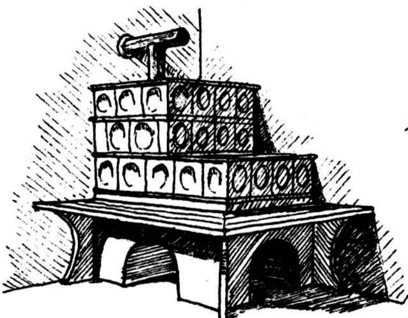
STOVE WITH HOOD,
VENEZUELA

EARLY JAPANESE STOVES HAD COOKING RECESSES AND A RICE STEAMER.



JAPANESE STOVE

THE AUSTRIAN KACHELOFEN DOUBLES AS A COOKSTOVE AND THE MAIN SOURCE OF HEAT. ITS TILES HOLD HEAT FOR LONG PERIODS.

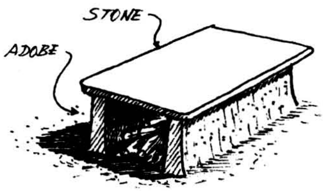


AUSTRIAN KACHELOFEN

INDIAN OVEN,
OKLAHOMA

THE HEMISPHERICAL OVEN EXPOSES A MINIMUM OF SURFACE AREA FOR HEAT LOSS (SEE PAGE 27), AND IT ALSO GIVES A VERY EVEN RADIANT HEAT WITHIN. THESE REASONS, PLUS THE FACT THAT IT IS EASY TO BUILD, HAVE MADE IT THE FAVORED FORM FOR CENTURIES.

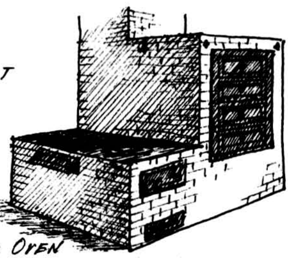
DOGON OVEN
UPPER VOLTA



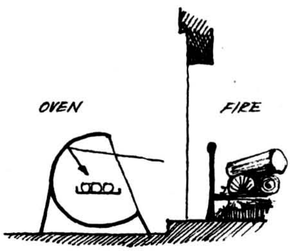
A SMALL FIRE INSIDE HEATS THE STONE SLAB FOR COOKING PIKI WAFERS.

PUEBLO INDIAN PIKI OVEN
NEW MEXICO

THE SHAKERS BUILT LARGE OVENS WITH SEVERAL REVOLVING RACKS FOR HIGH-VOLUME BAKING.

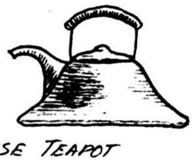


SHAKER OVEN
CANTERBURY, NEW HAMPSHIRE
(1876)



A SHEET METAL REFLECTOR OVEN FOCUSES A FIRE'S HEAT ONTO THE RACK AT ITS CENTER.

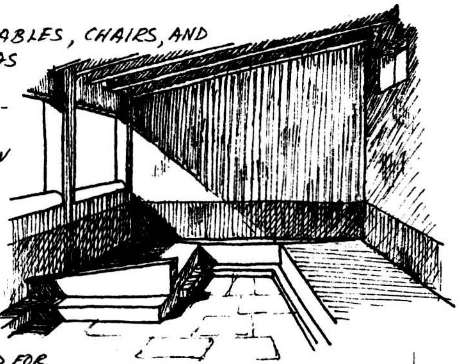
REFLECTOR OVEN
MASSACHUSETTS, 18th CENTURY



JAPANESE TEAPOT

THIS TEAPOT HAS AN EFFICIENT AND PRACTICAL SHAPE: MAXIMUM SURFACE AREA EXPOSED TO THE STOVE'S HEAT AND THE MINIMUM AREA EXPOSED TO THE AIR (DUE TO THE HEMISPHERICAL SHAPE).

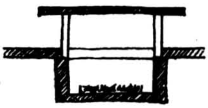
THE USE OF TABLES, CHAIRS, AND UTENSILS FOR DINING HAS OCCURRED ONLY IN THE LAST SEVERAL CENTURIES AND, IN MANY COUNTRIES, IS EVEN NOW NOT OBSERVED.



HOUSE OF CARO, POMPEII

THIS HOUSE HAS A U-SHAPED INCLINED DAIS THAT WAS USED FOR DINING. THE FOOD WAS SERVED FROM THE CENTER AREA.

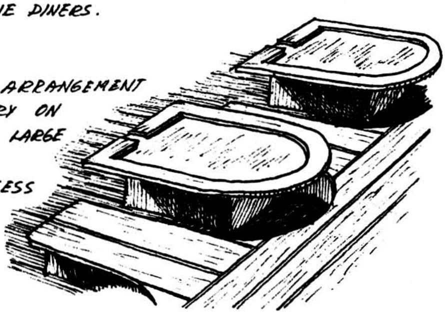
SECTION THROUGH DAIS AND SERVICE AREA



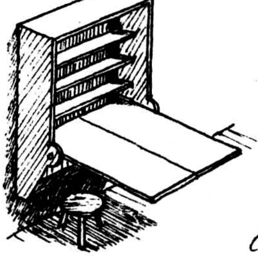
IN SOME OLDER JAPANESE HOMES THERE IS A RECESS, OR "HORIGOTATSU," IN THE FLOOR UNDER THE TABLE INTO WHICH HOT COALS ARE PLACED TO WARM THE FEET OF THE DINERS.

JAPANESE "HORIGOTATSU"

THE SEATING ARRANGEMENT IN THE ANCIENT MONESTARY ON MT. ATHOS ACCOMMODATES LARGE NUMBERS OF PEOPLE AND ALLOWS EASY SERVICE ACCESS AT THE END OF THE TABLE.



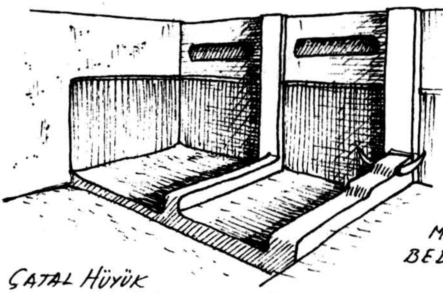
EATING TABLES AT THE MONESTARY ON MT. ATHOS, GREECE (A.D. 950)



THE FRONT OF THIS CUPBOARD SWINGS DOWN TO MAKE A TABLE.

CUPBOARD/TABLE, ALPS

SITTING



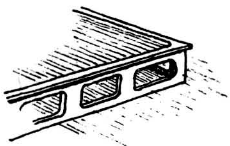
EVEN IN NEOLITHIC TIMES, BUILDERS WERE CREATING RAISED PLATFORMS FOR SITTING, WORKING, AND SLEEPING.

AT ÇATAL HÜYÜK THE PLASTERED DAIS WAS COVERED WITH MATS, CUSHIONS, AND BEDDING.

ÇATAL HÜYÜK
ANATOLIA (6000 B.C.)

AFRICAN VILLAGES VERY OFTEN HAVE A SHADED RESTING PLACE WHERE PEOPLE CAN QUIETLY GATHER AND CHAT OR JUST SIT.

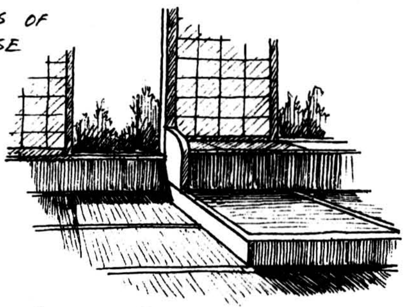
RESTING PLACE, DAHOMEY



UR PLATFORM, CHINA

THIS IS USED AS A DAIS FOR SITTING AND RECLINING.

RAISED SECTIONS OF THE FLOOR IN MANY JAPANESE BUILDINGS ARE USED FOR SITTING.



THE THREE-LEGGED STOOL

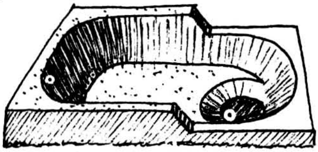
ON VERY UNEVEN FLOORS IT STILL SITS FLAT.

JAPANESE PAVILION
SHUGAKUIN IMPERIAL VILLA

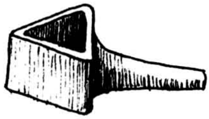
BATHING

AS THE HOUSE EVOLVED FROM A CRUDE SHELTER INTO A HOME, BATHING RECEIVED MORE ATTENTION.

THIS TERRA-COTTA HIP BATH WAS FOUND IN AN ELABORATELY TILED BATHROOM.



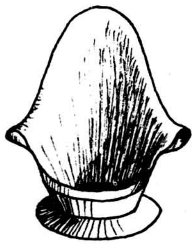
HIP BATH, OLYNTHUS (A.D. 300)



THE LONG DRAIN SPOUT ON THIS TRIANGULAR TERRA-COTTA SINK EXTENDED THROUGH THE WALL AND EMPTIED INTO A SEWER.

BASIN, OLYNTHUS, GREECE (A.D. 300)

THE USE OF PORTABLE TUBS SAVES THE SPACE TAKEN UP BY A PERMANENT BATHROOM AND ALLOWS ONE TO BATHE IN THE WARMTH OF THE KITCHEN.

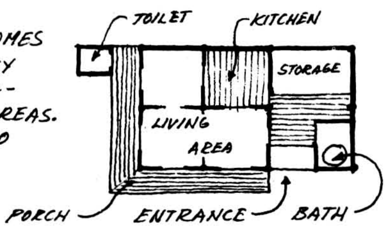


SHAKER BATHING TUB
SABBATHDAY LAKE, MAINE (1878)

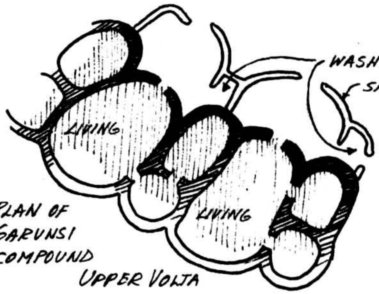
EARLY JAPANESE TUBS WERE MADE OF WOOD WITH A METAL-SHIELDED BOTTOM UNDER WHICH A FIRE WAS BUILT.

JAPANESE BATH TUB

OLDER JAPANESE HOMES KEPT THE HEAT AND MESSY FIRE OF THE BATH SEPARATED FROM THE LIVING AREAS. THE TOILET WAS ALSO SEPARATE, BUT FOR A DIFFERENT REASON.



WHEN POSSIBLE, MOST DOMESTIC ACTIVITIES IN HOT CLIMATES ARE DONE OUTSIDE, INCLUDING BATHING.

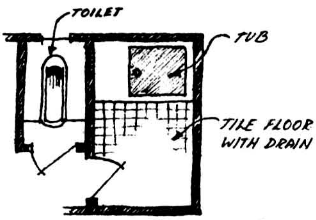


PLAN OF GARUNSI COMPOUND
UPPER VOLTA

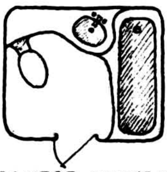
FOR PRIVACY WHILE WASHING, LOW-WALLED CUBICLES ARE ATTACHED TO THESE DWELLING COMPLEXES BUILT OF MUD.

IN JAPAN, BATHING RECEIVES A GREAT DEAL OF ATTENTION AND IS PRACTICALLY AN ART FORM.

AS SHOWN IN THIS CONTEMPORARY PLAN, THE JAPANESE BELIEVE IN SEPARATING THE BATH AND THE TOILET.



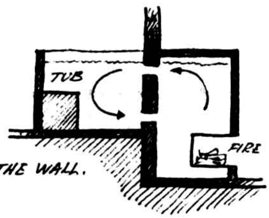
CONTEMPORARY BATH PLAN, JAPAN

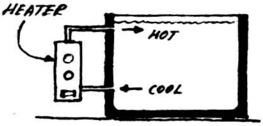


JAPANESE UNITIZED BATHROOM

ON THE OTHER HAND, THE JAPANESE HAVE ALSO PRODUCED ONE-PIECE, PLUG-IN, FIBERGLASS BATHROOM MODULES.

SOME EARLY WOOD-FIRED JAPANESE TUBS WERE INSIDE WHILE THE FIRE WAS OUTSIDE. THE WATER CIRCULATED THROUGH PORTS IN THE WALL.



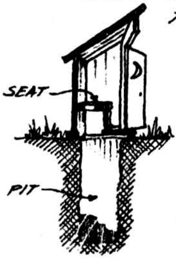


THE JAPANESE WASH OUTSIDE OF THE TUB, EITHER BY LADLING OUT WATER OR USING A SHOWER NOZZLE, AND THEN THEY GET IN THE TUB TO SOAK. THE SAME WATER CAN BE USED SEVERAL TIMES AND A CIRCULATING HEATER KEEPS IT VERY HOT.

ELIMINATION

WITH THE ESTABLISHMENT OF MORE PERMANENT SHELTERS CAME THE NEED FOR A SYSTEM TO DEAL WITH SEWAGE. FOR CENTURIES IN CHINA, HUMAN WASTE HAS BEEN CONSIDERED A VERY VALUABLE COMMODITY. IT IS COLLECTED, COMPOSTED, AGED, AND THEN USED AS A HIGH-QUALITY FERTILIZER, CALLED NIGHT SOIL.

ONE OF THE MORE PRIMITIVE WASTE DISPOSAL SYSTEMS IS THE OUTHOUSE.

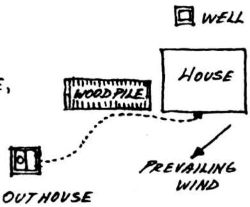


NEW YORK (CA. 1910)

THE OUTHOUSE IS SIMPLY A SEWER PIT TOPPED BY AN ENCLOSED TOILET SEAT. PERIODICALLY LIME IS ADDED TO THE PIT TO REDUCE ODORS AND WHEN IT IS FULL IT IS COVERED WITH EARTH, A NEW PIT IS DUG, AND THE OUTHOUSE IS PLACED OVER IT.

WHERE TO SITUATE THE OUTHOUSE:

1) PUT IT DOWNWIND FROM THE HOUSE,
2) KEEP IT AWAY FROM ANY WATER SOURCES,
3) PLACE THE WOODPILE BETWEEN IT AND THE HOUSE SO THAT COMMUTERS CAN BRING IN SOME WOOD ON THEIR RETURN TRIP.

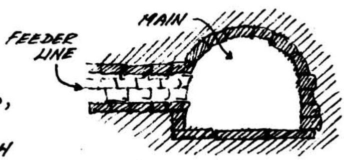


INDOOR FACILITIES:

MARMOT SUMMER BURROW

WHEN THE MARMOT EXCAVATES ITS BURROW IT DIGS A SHORT, SPUR TUNNEL THAT IS USED AS A TOILET.

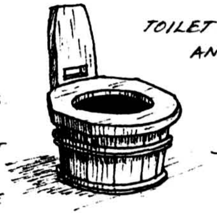
IN 3000 B.C. THE RESIDENTS OF OLYNTHUS HAD AN UNDERGROUND, BRICK-LINED SEWER SYSTEM THAT EVEN HAD LINES SERVING EACH SENTRY'S POST ON THE CITY WALL.



OLYNTHUS, GREECE

IN COLD CLIMATES, A TREK TO THE OUTHOUSE IS NOT TOO POPULAR, SO OFTEN A PRIVY IS BUILT INTO A CORNER OF THE BARN.

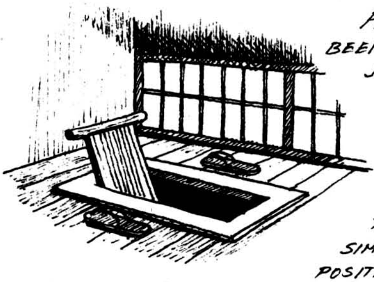
"DAS STILLE ÖRTCHEN" (LIT. "THE SMALLEST ROOM") MATTEN, SWITZERLAND (17th CENTURY)



TOILET MADE FROM AN OLD BUTTER CHURN

SWITZERLAND (1693)

THE TOILET WAS FIRST BROUGHT INTO THE HOUSE AS SIMPLY A BUCKET WITH A SEAT. THE BUCKET WAS EMPTIED DAILY AT THE DUNG HEAP.

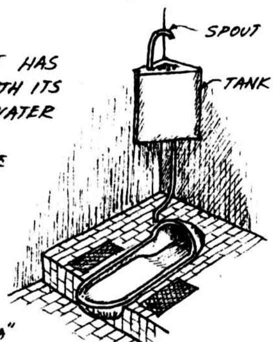


JAPANESE PRIVY (CA.1870)

PERSONAL HYGIENE HAS ALWAYS BEEN VERY IMPORTANT TO THE JAPANESE, WHICH IS EVIDENT IN THE FIXTURES THAT THEY HAVE DEVELOPED.

MOST OF THE WORLD'S CULTURES FAVOR THE SQUAT-TYPE TOILET BECAUSE IT IS SIMPLE, IT PROMOTES A NATURAL POSITION, AND IT IS VERY SANITARY.

THIS MODERN JAPANESE TOILET HAS TWO WATER-SAVING FEATURES: 1) WITH ITS DUAL FLUSH MODE, LITTLE OR MORE WATER CAN BE USED AS NECESSARY, AND 2) WATER REFILLING THE TANK CAN BE USED FOR WASHING ONE'S HANDS.



CONTEMPORARY JAPANESE TOILET

JAPANESE URINAL, OR "ASAGAOWA" (LIT. "MORNING FACE"; IT IS SUPPOSED TO RESEMBLE THE FLOWER OF THE MORNING GLORY) (CA.1870)

WORKING

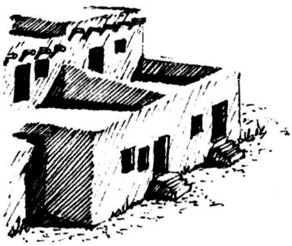
AS CIVILIZATION WENT BEYOND THE HUNTING/GATHERING PHASE AND THE COMPLEXITY OF DOMESTIC LIFE INCREASED, IT BECAME IMPORTANT TO HAVE SPACE IN THE SHELTER FOR NECESSARY TASKS AND FOR STORAGE.

MUKTELE HOUSE, CAMEROON

THE CIRCULAR COMPOUND OF HUTS PROTECTS AND DEFINES AN INNER YARD THAT IS USED AS AN OUTDOOR LIVING AREA, A WORK SPACE, AND A SAFE PLACE TO STORE THINGS.

THE FLAT ROOF HAS BEEN USED IN A VARIETY OF CLIMATES FOR CENTURIES AS A PRACTICAL AND SAFE PLACE FOR WORKING, SLEEPING, DRYING PRODUCE, AND KEEPING ANIMALS.

MOUNTAIN SETTLEMENT
ANDALUSIA, SPAIN

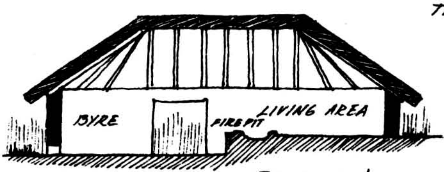


ACOMA PUEBLO
NEW MEXICO (CA. A.D. 900)

IN MANY AREAS, THE SHAPE OF THE HOUSE IS MANIPULATED TO CREATE BOTH OPEN AND SHADED EXTERIOR AREAS.

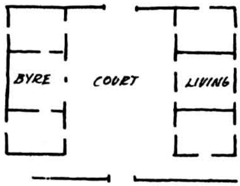
UNDER THESE VAULTS ARE SHADED OUTDOOR LIVING AND WORKING AREAS.
OSTUNI, ITALY

EARLY DWELLINGS IN TEMPERATE CLIMATES USUALLY HOUSED ALL ACTIVITIES UNDER ONE ROOF TO CONSERVE HEAT.



ENGLISH LONGHOUSE (PRE-1100)

SOME LATER HOMES SPLIT THE DWELLING AND THE BYRE AND CREATED A PROTECTED, PARTIALLY COVERED COURT BETWEEN THEM THAT SERVED A VARIETY OF USES.

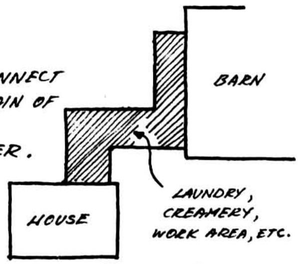


FRENCH FARMHOUSE PLAN

THE PROJECTING ROOF AND SIDE WALLS OF THIS BARN CREATE A PROTECTED OUTSIDE WORK AREA.

PEASANT DWELLING AND BARN, FRANCE

NEW ENGLAND BUILDERS CONNECT THE BARN AND HOUSE WITH A CHAIN OF WORK SPACES. THIS MINIMIZES THE NECESSITY OF GOING OUTSIDE IN WINTER.



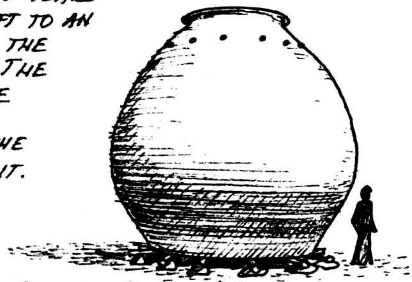
NEW ENGLAND FARMHOUSE (CA. 1800)

LOGGIAS PROVIDE LIVING AND WORKING SPACE THAT IS SHELTERED FROM BOTH THE RAIN AND THE SUN.

COURT AND LOGGIA, GREECE

STORAGE

CULTIVATION OF CROPS BEGAN AT LEAST 10,000 YEARS AGO AND WITH THIS SHIFT TO AN AGRARIAN SOCIETY CAME THE NEED TO STORE FOOD. THE GRANARY BECAME THE MOST IMPORTANT BUILDING IN THE SETTLEMENT.

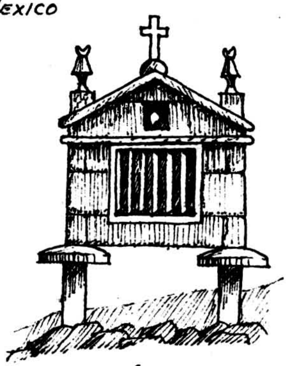


CLAY POT GRANARY, SUDAN

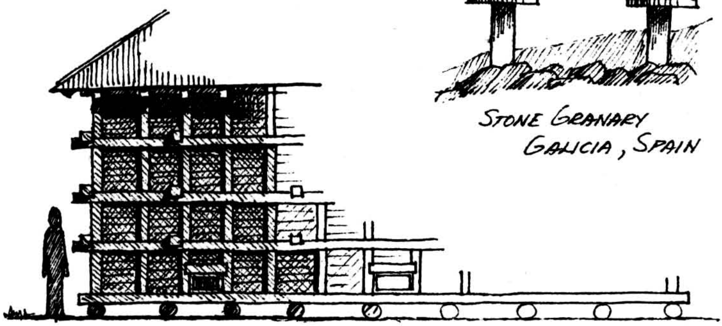
THE GRANARY WAS USUALLY THE FIRST STRUCTURE BUILT IN A SETTLEMENT AND WAS THE MOST METICULOUSLY CRAFTED.

MUD AND THATCH GRANARY, MEXICO

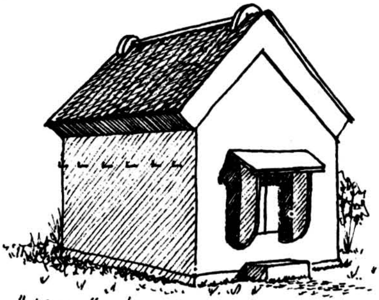
THIS ELABORATELY CARVED STONE GRANARY HAS LARGE FLAT STONES AT THE TOP OF EACH SUPPORTING POST AS A RAT GUARD.



STONE GRANARY GALICIA, SPAIN

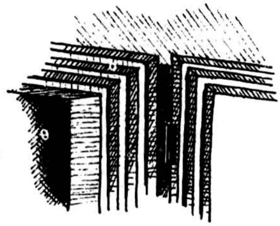


LARGE WOODEN GRANARY ELMALI, TURKEY (19th CENTURY)



"KURA", JAPAN
(CA. 1800)

THE IMPORTANCE OF RICE TO THE JAPANESE IS CLEARLY EVIDENT FROM A LOOK AT THE TILE AND STUCCO, FIREPROOF STRUCTURE, OR "KURA," WHERE IT IS STORED. THIS FORTRESS-LIKE BUILDING PROTECTS THE RICE FROM BOTH MOISTURE AND FIRE.



DETAIL OF THE VAULT-TYPE DOOR ON A "KURA."

RAISED STOREHOUSE, FINLAND

THIS ELEVATED STRUCTURE, OUT OF THE REACH OF SNOW AND ANIMALS, SERVES AS A STOREHOUSE AND TEMPORARY SHELTER FOR THE LAPPS.

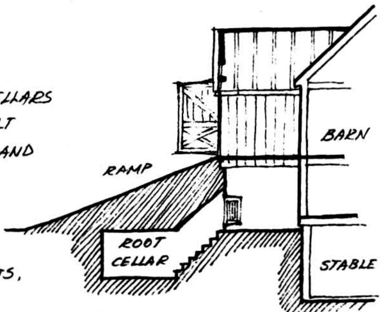
CORN CRIBS USUALLY HAVE OPEN, SLATTED WALLS TO ALLOW AIR TO FLOW THROUGH AND DRY THE CORN. SOME HAVE ADDITIONAL STORM FLAPS TO KEEP OUT DRIVING RAIN.

IN THIS EXAMPLE NOTE THE RAT GUARDS ON THE POSTS AND THE STEP THAT IS RETRACTED WITH A COUNTERWEIGHT TO PREVENT ANIMALS FROM REACHING THE CORN.

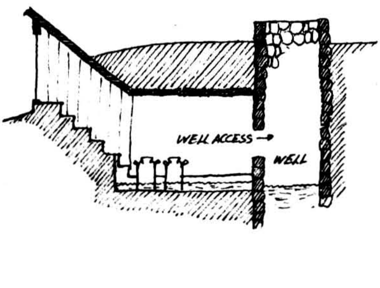
HIGHRISE STOREHOUSE
MEDENINE, TUNISIA

ROOT CELLAR
QUEBEC (1650)

ROOT CELLARS WERE USUALLY BUILT ABOVE GROUND TO STAY DRY AND THEN EARTH WAS PILED OVER THEM TO MAINTAIN A CONSTANT, COOL TEMPERATURE FOR STORING POTATOES, BEETS, TURNIPS, ETC.

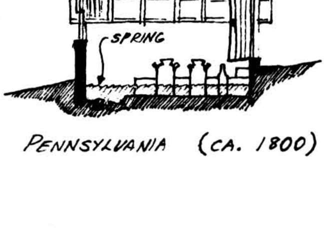


ROOT CELLAR UNDER BARN RAMP
PENNSYLVANIA (1830)



A WET GROUND-CELLAR IS AN UNDERGROUND STOREROOM ADJOINING A WELL. POOLS OF WELL WATER COOLED MILK, CIDER, ETC.

SPRINGHOUSES KEEP THE SPRING WATER CLEAN AND SUPPLY A POOL OF COOL RUNNING WATER TO CHILL MILK, ETC.

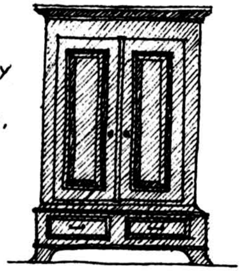


SPRINGHOUSE, PENNSYLVANIA (CA. 1800)

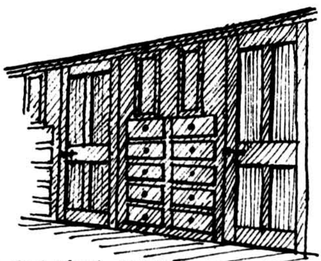
SECTION THROUGH THE STONE WALL OF A TRULLO DWELLING SHOWING A BUILT-IN STORAGE NICHE

APULIA, ITALY

A SIMPLE AND VERSATILE WAY TO STORE CLOTHES IS IN A WARDROBE. THESE MOVABLE PIECES ARE STILL VERY POPULAR IN EUROPE.

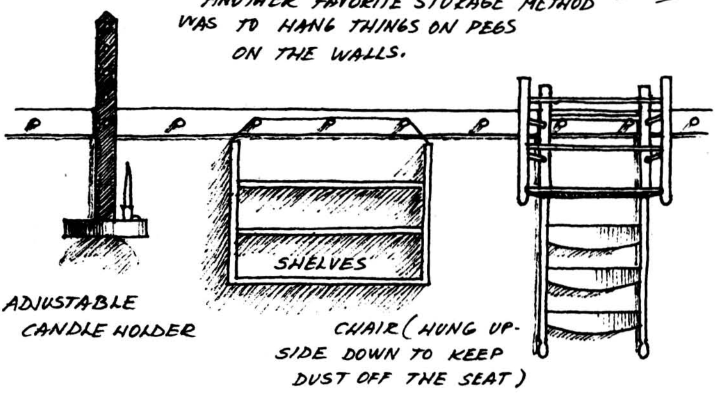


THE JAPANESE ARE NOTED FOR THEIR SIMPLE YET ELEGANT DESIGNS, SUCH AS THIS UTENSIL HOLDER, MADE OF NOTCHED BAMBOO.



THE SHAKERS TRULY BELIEVE IN "A PLACE FOR EVERYTHING, AND EVERYTHING IN ITS PLACE." THIS SERIES OF ATTIC CLOSETS AND DRAWERS IN CANTERBURY, N.H. ATTESTS TO THAT.

ANOTHER FAVORITE STORAGE METHOD WAS TO HANG THINGS ON PEGS ON THE WALLS.



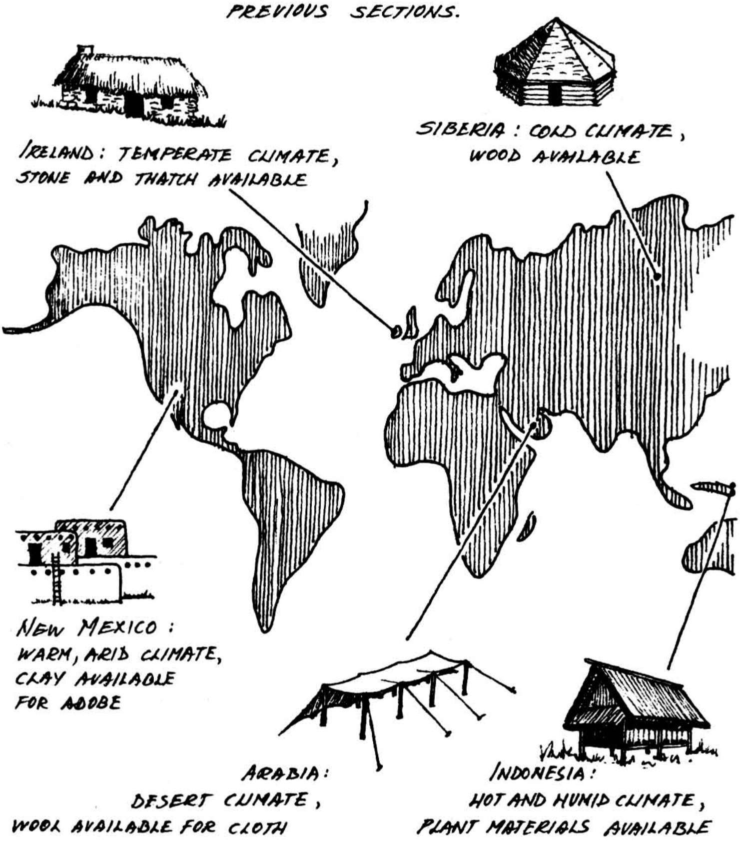
ADJUSTABLE CANDLE HOLDER

CHAIR (HUNG UPSIDE DOWN TO KEEP DUST OFF THE SEAT)

SECTION III - THE BUILDING ITSELF

REGIONALITY

OVER THE COURSE OF HISTORY, THE ENVIRONMENT HAS BEEN THE STRONGEST DETERMINANT OF WHAT FORM SHELTER WILL TAKE. IN ORDER TO BE SUCCESSFUL, A SHELTER MUST BE BUILT TO COUNTER LOCAL NEGATIVE ENVIRONMENTAL CONDITIONS, AND IT MUST BE CONSTRUCTED WITH AVAILABLE MATERIALS. THESE TWO FACTORS ARE CHIEFLY RESPONSIBLE FOR THE DISTINCTLY REGIONAL QUALITY OF PRE-INDUSTRIAL INDIGENOUS ARCHITECTURE. THIS SECTION OF THE BOOK EXAMINES THE MATERIALS AND TECHNIQUES THAT BUILDERS USED TO ACHIEVE THE GOALS MENTIONED IN THE PREVIOUS SECTIONS.



USING THE MATERIALS AT HAND

PALM FRONDS AND GRASS SUPPLY WEAVERBIRDS WITH THE MATERIALS NECESSARY TO CREATE THEIR INTRICATELY WOVEN, SPHERICAL NESTS.

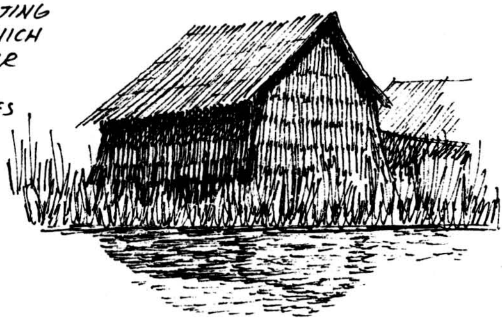
THE EARLIEST MAN-MADE SHELTER WAS MOST LIKELY A ROOF OF STICKS, BRANCHES, AND LEAVES BRIDGING A TROUGH IN THE TERRAIN.

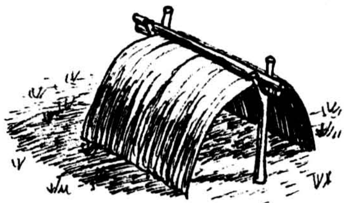
THIS ABORIGINAL SHELTER IN CENTRAL AUSTRALIA IS MADE OF ARCHED BRANCHES WITH A LEAF COVERING. THE FLOOR IS SLIGHTLY SCOOPED OUT.

THE BAMBUTI PEOPLE OF THE ITURI FOREST IN THE CONGO USE LARGE LEAVES TO COVER TWIG FRAMES AS A SIMPLE SHELTER.

THE DINKA TRIBE OF THE UPPER NILE USES SOME LOCAL MATERIALS IN PLACE. THE TWIG AND THATCH ROOF OF THIS HUT IS SUPPORTED BY THE TRIMMED BRANCHES OF A TREE.

On Lake Titicaca, in Peru, the Urus Indians have used totora reeds to create floating islands upon which they build their houses. The houses themselves are also built entirely of reeds.

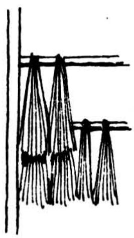




This primitive Australian hut is made of large sheets of bark bent over a simple stick frame.

For centuries, the Japanese have been displaying their mastery of the craft of thatching.

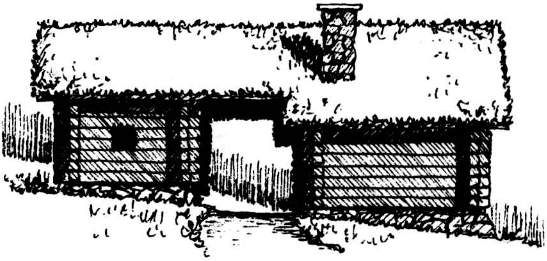
Takayama, Japan



The bound bundles of straw can be made into roofs (above) or walls (left). Thatch is used throughout the world because grass is so universally available and is replenishable.

In Norway, sod has long been used as a durable, insulating roof material. It is often placed over a layer of bark, which keeps water from seeping into the house.

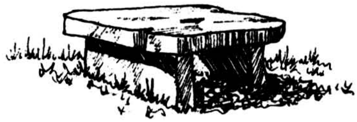
Section through roof



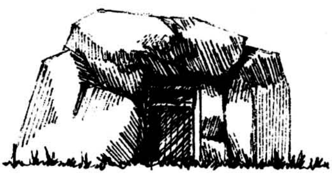
LOG HOUSE
WITH
SOD ROOF

OSTERDAL, NORWAY (17th CENTURY)

THE WELL-DIGGER JAWFISH BUILDS A HIDEAWAY FROM WHICH TO STRIKE AT PREY BY DIGGING A HOLE AND REINFORCING IT WITH PEBBLES AND SHELLS.



PERHAPS THE EARLIEST FORM OF MAN-MADE STONE BUILDING IS THE DOLMEN: A STRUCTURE OF STONE SLABS USED AS A BURIAL CHAMBER.



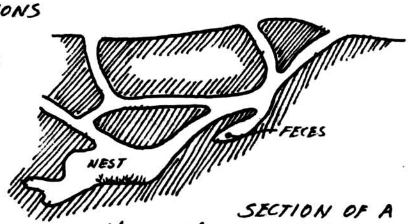
THIS PRE-DYNASTIC EGYPTIAN HOUSE WAS CREATED WITHIN A BOULDER FORMATION.

THIS TRULLO DWELLING IS BUILT OF UNMORTARED STONE, WHICH IS CORBELED TO CREATE A VAULTED INTERIOR.

MURGIA, ITALY
(CA. 1600)

THE MOST WIDELY AVAILABLE BUILDING MATERIAL IS THE EARTH ITSELF. FOR MILLIONS OF YEARS, ANIMALS HAVE BEEN LIVING IN BURROWS FOR PROTECTION FROM COLD, HEAT, MOISTURE, AND PREDATORS.

MANY BURROWS ARE EVEN EQUIPPED WITH SHORT TUNNELS USED AS BATHROOMS.

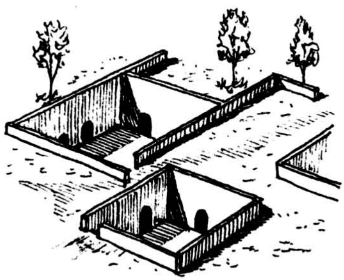


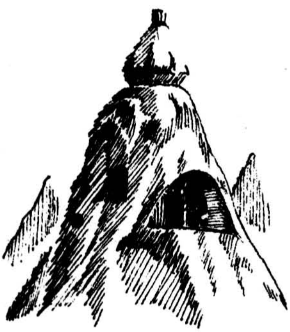
SECTION OF A MARMOT'S SUMMER BURROW

3,000 YEARS AGO, PEOPLE CARVED BURIAL CHAMBERS INTO THESE CLIFFS OF SOFT ROCK. DURING THE MIDDLE AGES THEY WERE CONVERTED INTO DWELLINGS.

CARVED CLIFF HOUSES, ANAPO VALLEY, SICILY

IN NORTHERN CHINA, A VERY LARGE NUMBER OF PEOPLE LIVE IN SUBTERRANEAN DWELLINGS CARVED INTO THE LOESS SOIL AND RADIATING FROM SUNKEN COURTYARDS.

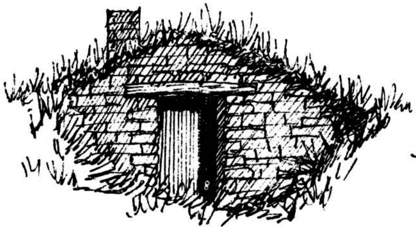

UNDERGROUND DWELLINGS NEAR LO-YANG, NO. CHINA



MANY ELABORATE, MULTI-LEVEL DWELLINGS HAVE BEEN CARVED FROM THE SOFT TUFA CONES OF CAPPADOCIA.

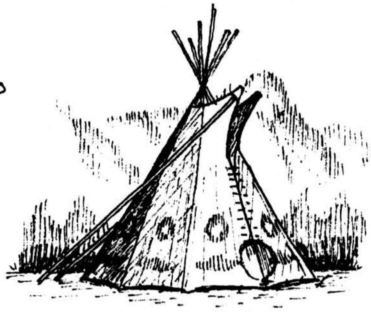
CAPPADOCIA, TURKEY

ANOTHER WAY TO USE EARTH FOR SHELTER IS TO CUT SOD BLOCKS AND USE THEM LIKE BRICKS TO BUILD WALLS.



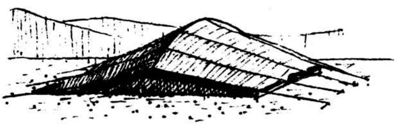
SOD HOUSE
AMERICAN MIDWEST
(CA. 1840)

THE ANIMALS HUNTED BY THE PLAINS INDIANS SUPPLIED THEM WITH FOOD AND SHELTER. THE DEMOUNTABLE POLE FRAMES OF THEIR TEPEES ARE COVERED INSIDE AND OUT WITH HIDES.



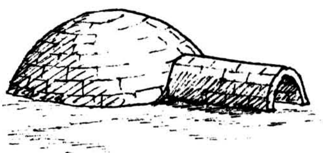
AMERICAN PLAINS INDIAN TEPEE

THE TEKNA TRIBES OF SOUTHWEST MOROCCO USE THE HAIR FROM SHEEP, GOATS, AND CAMELS AS THE RAW MATERIAL FOR THEIR TENTS. THESE PORTABLE AND EASILY ERECTED TENTS ARE WELL SUITED TO THE TEKNA'S NOMADIC LIFESTYLE.



TEKNA TENT
MOROCCO

IN A SUB-ARCTIC CLIMATE, SNOW IS ONE OF THE FEW MATERIALS AVAILABLE. MANY TRIBES HAVE USED SNOW BLOCKS IN CONSTRUCTION FOR CENTURIES. THE BLOCKS, EASILY CUT AND SHAPED, ARE LAID IN A SPIRALING PATTERN.



INUIT IGLOO
CANADA

Structural Systems

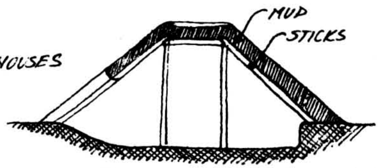
Our paleolithic ancestors might have taken refuge in some natural lean-to shelters of trees fallen against a bank or accross a gully.

Later, they learned how to build them themselves.

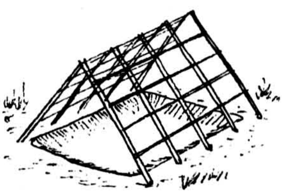
The next step may have been a lean-to roof resting on a crossbar.

The more common, circular dwelling may have originated with a lean-to radiating from a tree.

Neolithic man built pithouses that had a circular frame roof over a shallow pit.



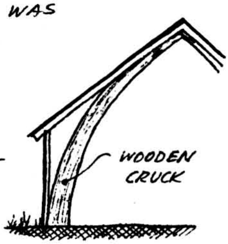
Pithouse, Pan-P'o, China (4000 B.C.)



The rectangular pithouse was a more rational form; the circular was more intuitive.

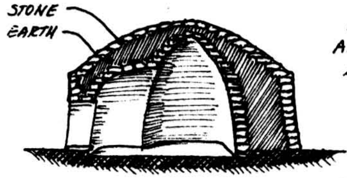
Tenchi-Gongen pithouse, Japan

The next phase was the differentiation of wall and roof.



English cruck building (1500)

STONE STRUCTURES



MORTARLESS STONE VAULTING APPEARED IN EGYPT AND MESOPOTAMIA BEFORE 3000 B.C. AND WAS OF THE CORBELED, TRULLO TYPE.

CORBELED STONEWORK

TRULLO HOUSE, MURGIA, ITALY (1400's)

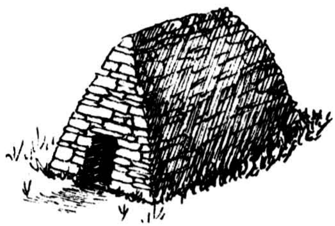
THE AEGEAN CULTURES OF GREECE AND CRETE MADE EXTENSIVE USE OF THE STONE LINTEL BECAUSE OF THE DURABLE STONE AVAILABLE TO THEM.

STONE LINTEL, GREECE

THE TRIANGULAR ARCH MARKED A TRANSITION FROM THE LINTEL TO THE ARCH.

WINDOW LINTEL, TIGRÉ HOUSE ETHIOPIA

VAULTED, UNMORTARED STONE STRUCTURES APPEARED IN EUROPE ALSO.



STONE ORATORY, IRELAND (6TH OR 7TH CENTURY)

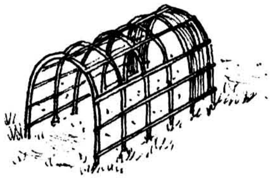
A COMMON BUILDING TYPE IS A MIXTURE OF MASSIVE STONE WALLS AND A LIGHT, EASILY CONSTRUCTED FRAME AND THATCH ROOF.

FARMHOUSE, SCOTLAND (18TH CENTURY)

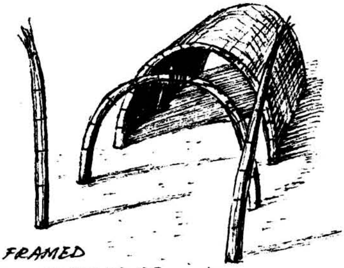
VAULTS AND DOMES

THE STICKLEBACK FISH BUILDS A VAULTED NEST BY CONSTRUCTING A SOLID, SEMI-CYLINDRICAL MASS OF PLANT MATERIAL AND THEN TUNNELING A HOLE THROUGH IT.

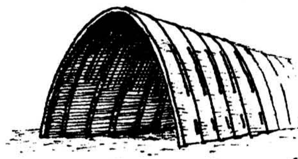
FOR CENTURIES, VARIOUS CULTURES HAVE USED PLANT MATERIALS TO FRAME AND COVER VAULTS.



INDIAN FRAME VAULT, AMERICA

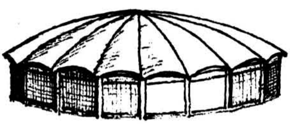


VAULT FRAMED WITH JOINED BUNDLES OF REEDS AND COVERED WITH REED MATS, IRAQ



AIRSHIP HANGAR, FRANCE (1916)

MORE RECENTLY, CONCRETE HAS BEEN USED TO BUILD THIN-SHELLED VAULTS



CONCRETE DOME, VIRGINIA (1964)

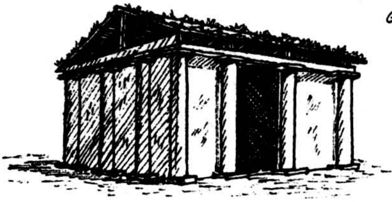
CONTEMPORARY DOMES ARE OFTEN OF PRECAST CONCRETE SECTIONS BOUND BY A BAND, OR TENSION RING, AROUND THE PERIMETER.

A VERY ANCIENT, INTUITIVE HOUSE FORM IS THE DOME, OR BEEHIVE SHAPE.

KHOISAN HUT SOUTH AFRICA

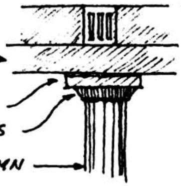
POST AND LINTEL

IT IS EASY TO SEE HOW THE LATER GREEK MONUMENTAL ARCHITECTURE EVOLVED FROM THIS SIMPLE, PRIMITIVE HUT, WHICH HAS TREE TRUNK POSTS AND TIMBER ROOF FRAMING.

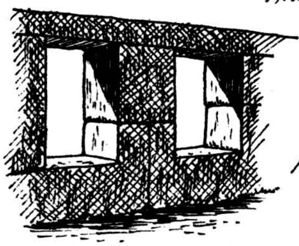


GREEK HUT (PRE-3000 B.C.)

THE CAPITAL ATOP EACH COLUMN SPREADS THE SUPPORT OF THE COLUMN ALONG THE ARCHITRAVE.

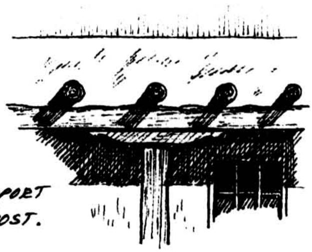


ANCIENT EXAMPLES OF STONE CONSTRUCTION USING MASSIVE LINTEL BLOCKS CAN BE FOUND THROUGHOUT CENTRAL AND SOUTH AMERICA.



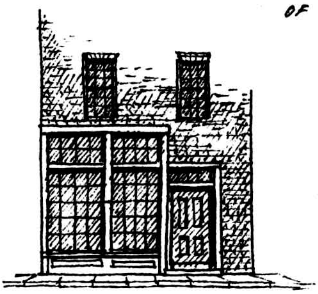
MACHU PICCHU, PERU (CA. 1500)

WHERE POSTS AND BEAMS ARE USED IN PUEBLO ARCHITECTURE, A ZAPATA IS USUALLY ADDED, LIKE A CAPITAL, TO SPREAD THE SUPPORT OF THE POST.



SANTA FE, NEW MEXICO (CA. 1860)

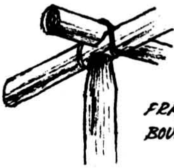
IN HOLLAND, WOOD POST AND BEAM CONSTRUCTION IS USED TO SUPPORT MASONRY WALLS WHILE PROVIDING LARGE OPENINGS FOR STORE WINDOWS.



AMSTERDAM, HOLLAND (CA. 1850)

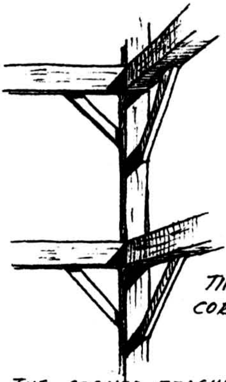
THE FRAME

A FRAME STRUCTURAL SYSTEM WITH A SKIN OF ROOF AND WALLS HAS SEVERAL ADVANTAGES OVER SOLID BUILDINGS. IT IS LIGHTER, CAN BE ASSEMBLED MORE QUICKLY, IS OFTEN DEMOUNTABLE, USES MATERIALS MORE ECONOMICALLY, IS EASY TO ALTER AND EXPAND, AND CAN FLEX TO RESIST EARTHQUAKES.

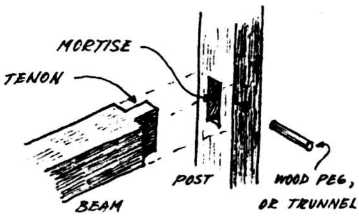


FRAME OF BOUND POLES
VENEZUELA

MURO-JI SHRINE
JAPAN



TIMBER FRAME WITH CORNER BRACING



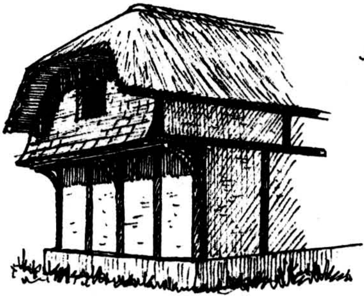
MORTISE AND TENON JOINT

THE CORNER BRACING HELPS A FRAME STRUCTURE TO RESIST LATERAL FORCES SUCH AS WIND AND EARTHQUAKES (SEE PAGE 25).

THE HALF-TIMBER STRUCTURE HAS WALLS OF STONE, BRICK, PLASTER, OR WATTLE AND DAUB (SEE PAGE 121), WHICH FILL IN THE AREAS BETWEEN THE TIMBERS, LEAVING THEM EXPOSED.

HALF-TIMBER HOUSE, DENMARK

THE CANTILEVER

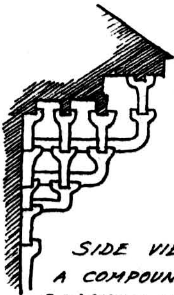


THIS OVERHANGING, OR JETTIED, SECOND FLOOR ADDS SPACE UPSTAIRS AND ALSO PROTECTS THE LOWER WALL FROM THE WEATHER.

KENT, ENGLAND
(15TH CENTURY)

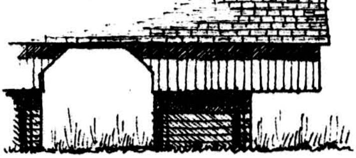
THIS BRACKET, CALLED A BRESSUMMER, SUPPORTS THE JETTY.

(ENGLAND)

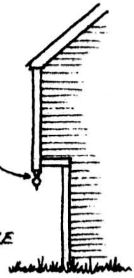


SIDE VIEW OF A COMPOUND BRACKET, WHICH IS COMMON IN JAPANESE ARCHITECTURE.
(CA.1500)

THIS UPPER FLOOR AREA IS CANTILEVERED OVER A RIVER AND IS SUPPORTED BY DIAGONAL BRACES.
LUXEMBOURG



OVERSHOT BARN; TENNESSEE



GARRISON STYLE

MASSACHUSETTS
(17TH CENTURY)

The potter wasp builds small clay pots to protect its eggs. It gathers small balls of clay, which it moistens, fashions into flat, narrow strips, and uses to build up the wall of the pot. It then lays an egg inside suspended over a collection of paralyzed insects that will be food for the larva. The top is then corked with a ball of clay. When the young wasp is large enough, it breaks out of its pot.

Potter wasp clay pots

Semi-spherical clay hut
Afghanistan

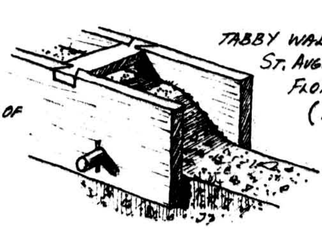
The round mud hut of the Massa tribe in the Sudan is built of successive courses of mud, laid and shaped by hand, forming a cylinder and topped with a thatch roof.

Massa mud hut
Logone River
Sudan

Some structures built by the Honokam Indians of Arizona were constructed by building up courses of hand-shaped mud two to three feet high.

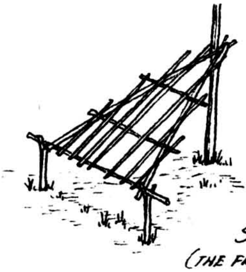
Casa Grande, Arizona (ca. 1250)

The Spanish technique of using board forms to hold the poured wall while it cured was used in the construction of tabby walls. (See page 71.)



Tabby wall
St. Augustine, Florida
(1750)

The Roof

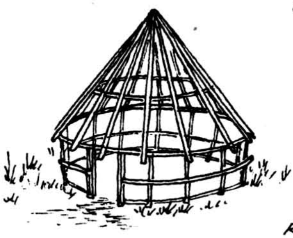


Perhaps the first man-made roof form was the lean-to. It is a simple, intuitive answer to the need for shelter.

"Banab," or rain shelter, of the Southern Guiana Indians
(The frame gets a cover of brush.)

One of the earliest and simplest roof forms is the cone. Of all the shapes that can be built using straight members, the conical roof offers a maximum of floor area with a minimum of exposed surface area.

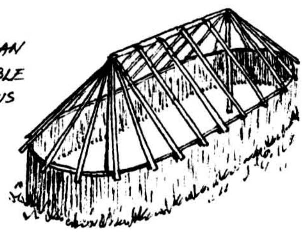
Penobscot Indian Tepee



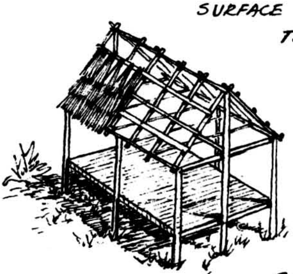
Usable living space can be increased when the conical roof is raised on outer walls.

Wai Wai Dwelling
British Guiana

This example shows an interesting combination of gable and conical roofs. The gable allows for a large interior space and the conical ends minimize surface exposure there.



Jibaru Jivaria, Ecuador

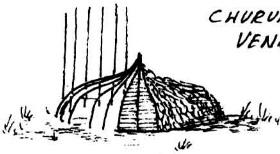


The gable roof allows for better through-ventilation and also permits easy linear expansion of the structure. (A circle is more difficult to expand than a rectangle.)

Seminole Lodge

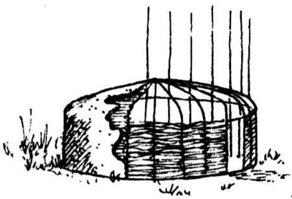
DIFFERENTIATING THE ROOF AND WALL

IN SIMPLE, PRIMITIVE DWELLINGS THERE IS NO DIFFERENTIATION BETWEEN THE ROOF AND THE WALLS.



CHURUVATA HUT
VENEZUELA

THE CHURUVATA HUT OF THE VENEZUELAN INDIANS IS MADE BY PLACING A CIRCLE OF POLES IN THE GROUND, THEN BENDING THEM INTO A DOUBLE CURVE AND BINDING THEM AT THE TOP.

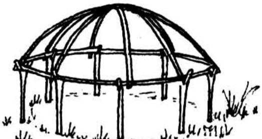


MASAI HOUSE
AFRICA

THE MASAI BUILD THEIR HUTS IN A SIMILAR WAY EXCEPT THAT TWIGS, WOVEN BETWEEN THE SAPLING POLES, CREATE A VERTICAL WALL. ABOVE WHICH THE SAPLINGS ARE BENT TO ARC ACROSS TO THE OTHER SIDE. THE HOUSE IS LATER PLASTERED WITH A MIXTURE OF MUD AND DUNG.

THE ADDED SUPPORTING POLES AROUND THE PERIMETER OF THIS HOUSE SUGGEST THE BEGINNINGS OF A SEPARATE WALL SYSTEM.

WICHITA INDIAN HOUSE



MARQUESAS IS. HOUSE

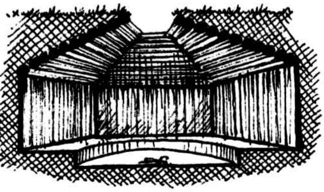
IN THIS HOUSE, THE WALL STRUCTURE IS PLAINLY SEPARATED FROM THE ROOF. THIS RESULTS IN THE ELIMINATION OF THE THE UNUSABLE LOW-CEILINGED SPACE AT THE PERIMETER.

HOUSE FORMS THAT AVOID THE TRANSITION FROM WALL TO ROOF ARE STILL POPULAR TODAY BECAUSE THEY ARE EASY TO BUILD, USE FEWER MATERIALS, AND OFFER GOOD PROTECTION FROM THE WEATHER.

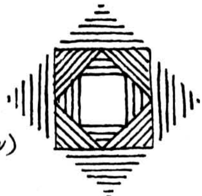
A-FRAME HOUSE, VERMONT

Wood Roof Structures

Where available, wood has always been a popular building material because it is easy to shape and is relatively light. In some primitive buildings it was laid in courses or corbeled like stonework.



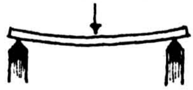
Section through log dome
Mesa Verde, Colorado

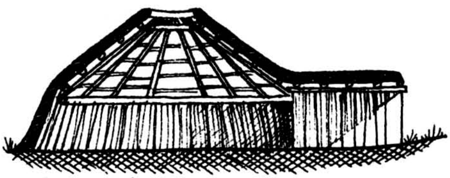


Log dome, Pakistan
(viewed from below)

Because of its fibrous nature, wood is able to resist bending forces better than materials such as stone, which fracture easily. For this reason, wood has been favored for centuries as a good material to span the living space and support the weight of the roof and snow.

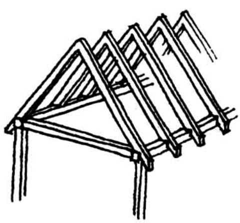
Bending force





Mandan House, American Northern Plains

Prehistoric pithouse with pole roof



House frame
Pennsylvania
(ca. 1700)

The sane framing system used in the prehistoric pithouse above is the most common roof construction technique used today. It consists of rafters spanning from the wall sill or beam to the ridge. Modern framing usually includes a board at the ridge.

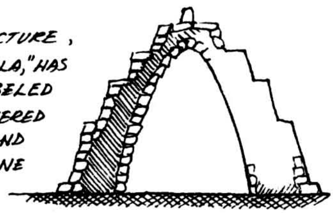
IN AREAS WHERE HEAVY TIMBER WAS NOT AVAILABLE FOR USE AS STRAIGHT ROOF BEAMS THE VAULT AROSE AS A SUBSTITUTE. BY SIMPLY SECURING ONE END OF A SAPLING, BENDING IT, AND SECURING THE OTHER END ONE CAN CREATE AN ARCH. A SERIES OF THESE FORMS A VAULT. IT IS NO SURPRISE THAT THIS IS, PERHAPS, THE MOST WIDESPREAD ROOF FORM.

VAULTED HOUSE
CAREENING BAY, AUSTRALIA

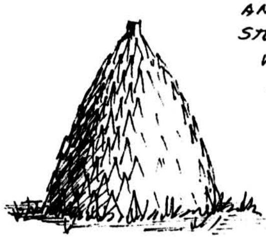
ALTERNATIVE MATERIALS, SUCH AS STONE, CLAY, OR BRICK, ARE STRONG WHEN BEING COMPRESSED BUT WEAK WHEN BEING BENT. A HORIZONTAL ROOF BEAM EXPERIENCES BENDING, BUT IN A VAULT OR DOME ALL THE ELEMENTS ARE UNDER COMPRESSION, SO IT IS A FORM THAT IS PARTICULARLY SUITED TO THOSE MATERIALS.

BARREL VAULTED HOUSES
GREECE

THIS STRUCTURE, CALLED A "CASELLA," HAS AN INNER CORBELED STONE DOME COVERED WITH EARTH AND AN OUTER STONE SURFACE.



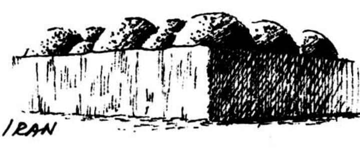
"CASELLA"; APULIA, ITALY



CONICAL DOMED ROOF OF HAND-MOLDED CLAY

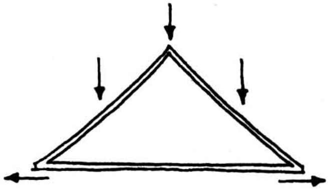
NORTHERN CAMEROON

MUD BRICK SAIL VAULTS BUILT ON RUBBLE STONE WALLS



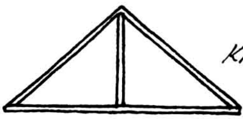
CARAVANSARAI; QUM, IRAN

TRUSSES



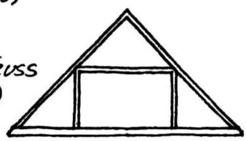
IN A SIMPLE GABLE ROOF, THE DOWNWARD FORCES FROM THE WEIGHT OF THE ROOFING AND ANY SNOW WILL CAUSE BENDING IN THE RAFTERS AND EXERT AN OUTWARD FORCE AT THE BASE OF THE ROOF.

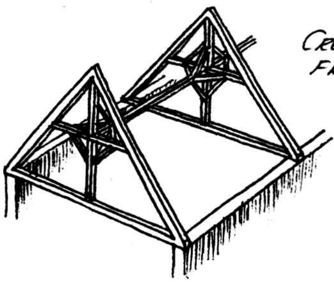
TRUSSES GIVE THE RAFTERS ADDITIONAL BRACING AND TIE THE BASE OF THE ROOF TOGETHER SO THAT IT DOESN'T SPREAD AND COLLAPSE.



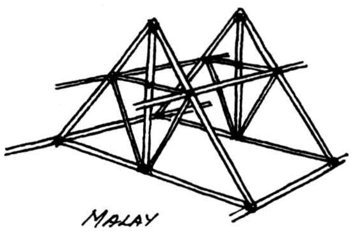
KINGPOST TRUSS
ENGLAND (CA. 1700)

QUEENPOST TRUSS
ENGLAND (CA. 1800)



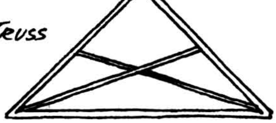


CROWN POST TRUSS
FRANCE (CA. 1300)



MALAY
LASHED TRUSS

SCISSORS TRUSS

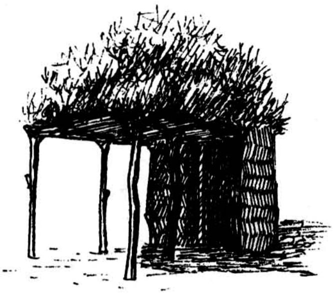


ROOFING MATERIALS

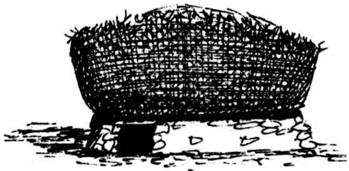
VEGETAL ROOFS:

ROOF OF PALM LEAVES
LAID SHINGLE STYLE

JOHORE, MALAYSIA



KIRDI HUT WITH ROOF
OF PILED GRASS



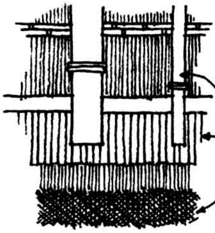
MULTI-LAYER, BUILT-UP
THATCH ROOF
SUDAN

THATCHED COTTAGE
FRANCE (CA. 1885)

THATCHED ROOF
WITH A PARTIAL HIP ON
A GABLE, CALLED A
JERKIN HEAD

HAMPSHIRE, ENGLAND

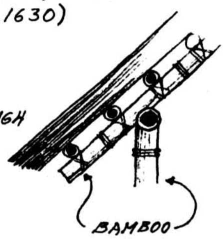
THATCH:

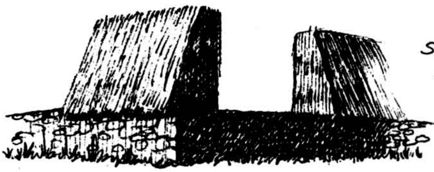


VIEW OF UNDERSIDE OF REED AND THATCH ROOF WITH BAMBOO RAFTERS

KATSURA, JAPAN
(CA. 1630)

SECTION THROUGH BAMBOO SUPPORTED THATCH ROOF (JAPAN)

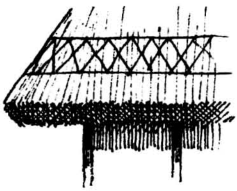




GRASS THATCH HUTS INSIDE A STONE ENCLOSURE (MARQUESAS ISLANDS)

STEEP ROOFS DIVERT HEAVY, TROPICAL RAINS

SECTION THROUGH ROOF SHOWING OVERLAP ON STONE WALL



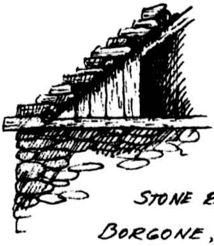
ROPE STITCHING TO PREVENT WIND FROM LIFTING THE THATCH
SUSSEX, ENGLAND
(CA. 1699)

HAT-LIKE CAPS ON THATCHED ROOFS GIVE ACCESS TO GRANARIES.

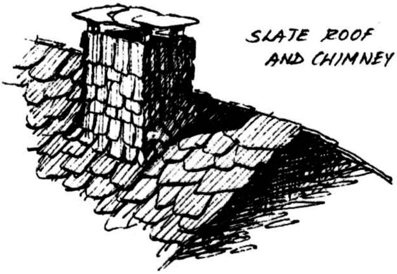
DORMER WINDOWS IN A THATCHED ROOF

KENT, ENGLAND

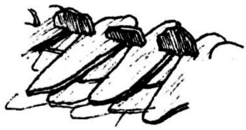
STONE ROOFS



STONE ROOF AND WALL
BORGONE, ITALY

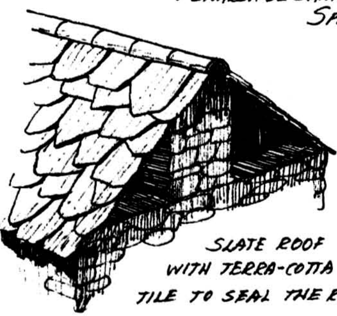


SLATE ROOF AND CHIMNEY



DETAIL OF INTERLOCKING SLATES AT THE ROOF RIDGE

PENALBA DE SANTIAGO, SPAIN



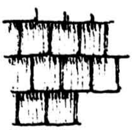
SLATE ROOF WITH TERRA-COTTA TILE TO SEAL THE RIDGE

CHAMONIX, FRANCE

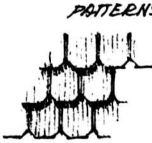
SLATE ROOF WITH ROCKS TO PREVENT WIND DAMAGE

SWITZERLAND

SOME CUT SLATE PATTERNS

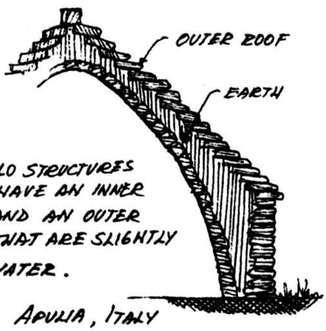


SQUARED



BEVELED

DIAMOND



THE TRULLO STRUCTURES OF APULIA HAVE AN INNER STONE VAULT AND AN OUTER ROOF OF STONES THAT ARE SLIGHTLY TILTED TO DIVERT WATER.

APULIA, ITALY

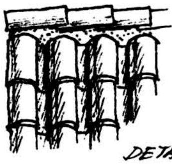
TILE ROOFS

PANTILE ROOF
NETHERLANDS (17th CENTURY)

MISSION TILE ROOF
MEXICO

MISSION
TILE

MEXICO (CA.1800)



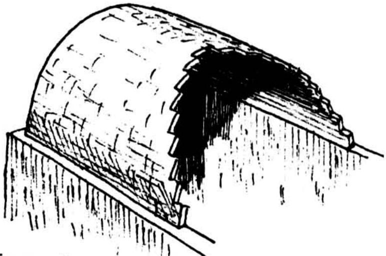
DETAIL OF
CEMENTED JOINT AT
THE RIDGE

TILED GABLE AND SHED ROOFS
PROVENCE, FRANCE

JAPANESE YEDO TILE

TILED HOUSE, HAKODATE,
JAPAN (CA.1880)

TILES AT THE
EAVES HAVE
AN ORNAMENTAL
DESIGN.



VAULTED ROOF UNDER
CONSTRUCTION; NOTE THE
RECTANGULAR BRICK-LIKE
TILE BLOCKS.

TUNISIA

WOODEN ROOFS

IN AREAS WHERE TREE BARK CAN BE HARVESTED IN LARGE SHEETS, IT IS OFTEN USED AS A ROOFING MATERIAL. IN THIS EXAMPLE, POLES SECURE THE BARK.

BARK COVERED HUT
NEW ENGLAND INDIANS
(CA. 1600)

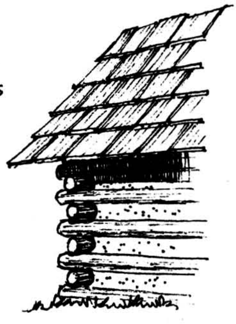
THICK SLABS OF BARK CAN ALSO BE USED LIKE MISSION TILES (SEE PAGE 112).

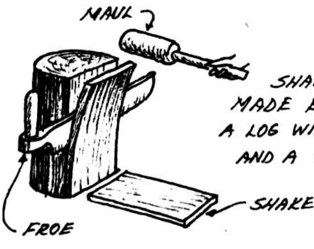
LOGS THEMSELVES HAVE SOMETIMES BEEN USED FOR ROOFING, AS IN THE SCOOP-LOG ROOF (RIGHT), OR THE SPLIT LOG ROOF (LEFT).

SCOOP-LOG ROOF

SPLIT LOG ROOF
HELSINKI, FINLAND

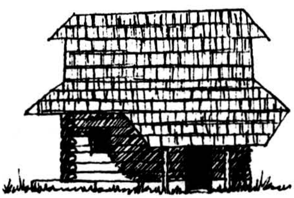
ROOF OF HAND-SPLIT SHAKES
NORTH CAROLINA
(CA. 1750)





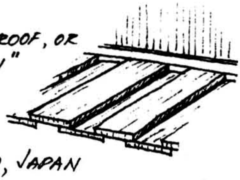
SHAKES ARE MADE BY SPLITING A LOG WITH A FROE AND A MAUL.

ROOF OF SHAPED BOARDS
HORIUJI, JAPAN



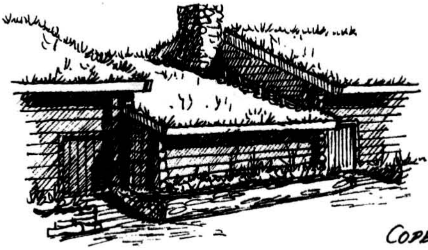
LOG HOUSE WITH SHINGLE ROOF
CZECHOSLOVAKIA (1903)

BOARD ROOF, OR "HISASHI"



KYOTO, JAPAN

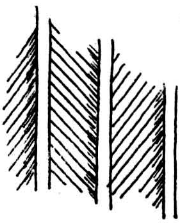
ROOFS OF EARTH



FOR WEATHER PROTECTION, THE NEXT BEST THING TO DIGGING INTO THE EARTH IS TO PILE EARTH ON TOP.

SOD-ROOFED CABIN
COPENHAGEN, DENMARK

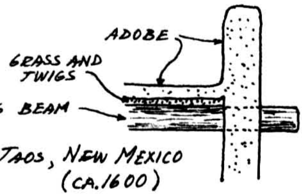
WHEN PROPERLY PACKED AND FINISHED, AND KEPT FREE OF STANDING WATER, A ROOF MADE FROM MUD CAN BE IMPERVIOUS TO RAIN AND CAN INSULATE THE DWELLING.



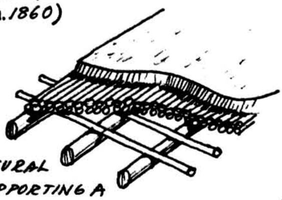
HERRINGBONE PATTERN OF CEILING BOARDS SUPPORTING AN ADOBE ROOF.

SAN ANTONIO, TEXAS (CA. 1860)

ADOBE ROOF

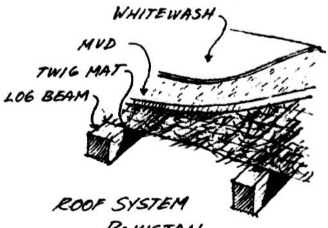


TAOS, NEW MEXICO
(CA. 1600)



STICK AND POLE STRUCTURAL SYSTEM SUPPORTING A ROOF OF CALICHE, A SOIL WITH A HIGH LIME CONTENT.

CASA GRANDE, ARIZONA (CA. 1250)



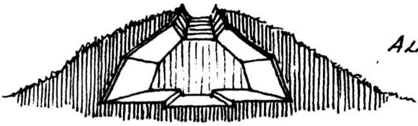
ROOF SYSTEM
PAKISTAN

THE BUILDERS OF THE SOD HOUSES OF THE PLAINS STATES USED SOD TO CONSTRUCT THE WALLS AND ALSO AS A COVERING FOR THE WOOD ROOF.

NEBRASKA SODDIE (CA. 1886)

THE CUBITERMES TERMITES USE SOIL PARTICLES CEMENTED WITH EXCREMENT TO BUILD THEIR LARGE, MUSHROOM-SHAPED COLONIES. THE DOMED ROOF ACTS LIKE AN UMBRELLA TO DIVERT THE HEAVY TROPICAL RAINS.

CUBITERMES COLONY

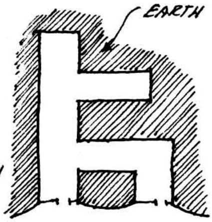


ALASKAN ESKIMO WINTER HOUSE WITH EARTH COVERING

FRONT ELEVATION

ONLY THE TWO SMALL GABLE ENDS OF THIS EARTH-COVERED HOUSE ARE EXPOSED TO THE WEATHER.

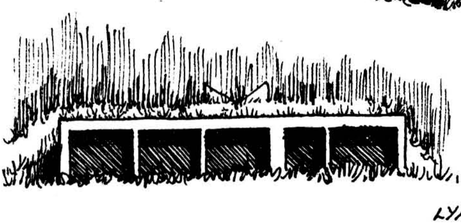
PLAN



GREECE (1876)

MANY OF THE OLD BUILDINGS IN ICELAND HAVE THEIR WALLS PROTECTED FROM THE COLD BY LARGE MASSES OF EARTH. BLOCKS OF TURF ARE COURSED IN A HERRINGBONE PATTERN AND ALSO CARRIED UP OVER THE ROOF.

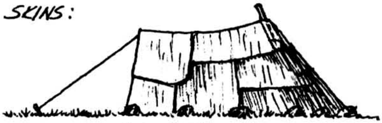
OLD CHURCH
ICELAND



CONTEMPORARY EARTH-SHELTERED HOUSE
LYME, NEW HAMPSHIRE

OTHER ROOFING MATERIALS :

SKINS :



INUIT "TUPIQ"
THE INUIT SUMMER DWELLING, OR "TUPIQ," IS MADE FROM SEALSKINS STRETCHED OVER A WOODEN FRAME AND HELD SECURE BY GUY ROPES AND ROCKS AROUND THE PERIMETER.

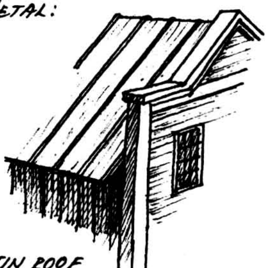
PLAINS INDIAN TEPEE
A SKIN MEMBRANE IS ATTACHED TO BOTH THE INSIDE AND THE OUTSIDE OF THE POLES.

FABRIC :

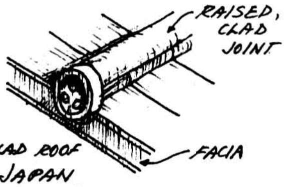
MOOR TENT FROM MAURETANIA
FABRIC MADE OF GOAT HAIR IS STRETCHED OVER A FEW POLES AND STAKED WITH THE OPENING DOWNWIND.

YURT FROM KIRGHIZISTAN
MULTI-LAYER GOAT HAIR FABRIC IS TIED OVER A WOODEN FRAME.

METAL :



TIN ROOF
ELKHORN, MONTANA (CA. 1890)
IT WENT UP QUICKLY BUT WAS A POOR INSULATOR.



COPPER CLAD ROOF
NIKKO, JAPAN
(CA. 1500)
IT WEATHERS WELL AND TAKES ON A NICE PATINA.

OTHER :

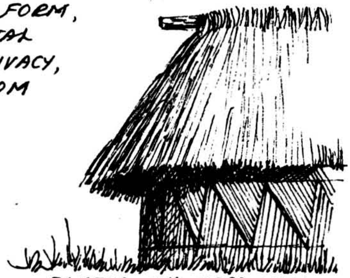
DULLES AIRPORT, VIRGINIA
CABLE-SUPPORTED CONCRETE ROOF

AIR-SUPPORTED TENNIS COURT ENCLOSURE OF SYNTHETIC FABRIC, BOSTON

THE WALL

AS THE WALL BECAME A SEPARATE STRUCTURE FROM THE ROOF IT ALSO TOOK ON SEPARATE FUNCTIONS. BEYOND INSULATING THE HOUSE, THE ROOF IS BUILT TO KEEP OUT RAIN, SNOW, AND SUN, WHILE THE PRIMITIVE WALL DEALS WITH WIND, ANIMALS, AND NEIGHBORS.

IN ITS SIMPLEST FORM, THE WALL IS A LIGHT VEGETAL MEMBRANE THAT OFFERS PRIVACY, SHADE, AND PROTECTION FROM WIND AND RAIN.

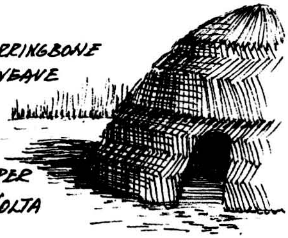


BAMBOO AND REED WALL
FIJI ISLANDS

AÏR-TUAREG TENT
WITH MOVABLE WALLS OF
WOVEN STRAW

WOVEN WALLS OFFER SHADE AND RAIN PROTECTION BUT ALLOW SOME AIR FLOW, WHICH IS ESSENTIAL IN HUMID CLIMATES.

HERRINGBONE
WEAVE



UPPER
VOLTA

WALL OF SAPLINGS
LAID BETWEEN
PAIRS OF PERI-
METER POSTS

POKOT DWELLING
KENYA

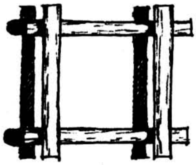
STILT HOUSE
WITH SPLIT
BAMBOO
WALLS

SOUTH DAHOMEY

ROLL-DOWN
WOVEN WALL
PANELS

GILBERT
ISLANDS

THE LOG WALL



PLAN OF A "SRUB"

THE INSULATING PROPERTIES OF SOLID WOOD AND THE PREVALENCE OF FORESTS IN COOLER CLIMATES PROMOTE LOG WALL CONSTRUCTION IN THOSE AREAS.

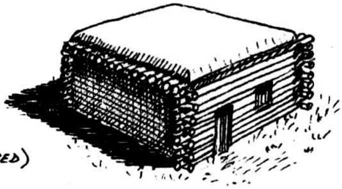
RUSSIA HAS SOME OF THE EARLIEST LOG STRUCTURES. THEY ARE BASED ON A UNIT CALLED A "SRUB," A SIMPLE SQUARE FORMED BY FOUR TREE TRUNKS. THE NOREGIANS EXTENDED THE SIDES BY JOINING SEVERAL LOGS END-TO-END.

CROSS SECTIONS OF COMMON LOG TREATMENTS:

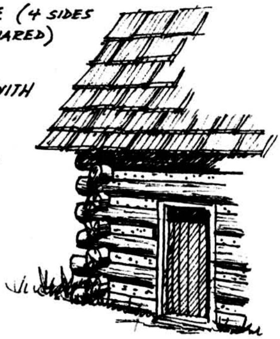
RUSSIAN (UNTRIMMED)

NORWEGIAN (2 SIDES SQUARED)

ALPINE (4 SIDES SQUARED)

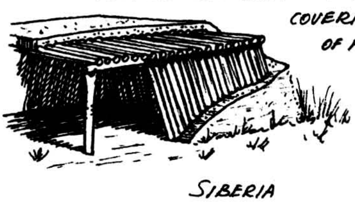


YUKAGHIR LOG HOUSE WITH A SOD ROOF
SIBERIA



LOG CABIN WITH CHINKING TO SEAL THE GAP BETWEEN THE LOGS.

INDIANA (CA. 1850)

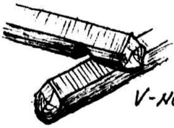


YAKUT
VERTICAL LOG WALL WITH COVERING OF MUD

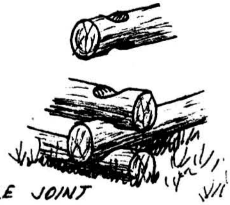
SIBERIA

LOG STOREHOUSE
ALVROS, SWEDEN (CA. 1753)

THE MORE PRIMITIVE LOG JOINTS ARE MADE BY CUTTING A SMALL SADDLE OUT OF THE TOP AND BOTTOM OF EACH LOG.

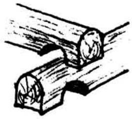


V-NOTCH



SADDLE JOINT

SHAPING THE LOG SO THAT IT HAS A PEAKED UPPER SURFACE AND CUTTING V-NOTCHES IN THE BOTTOM CREATES A JOINT THAT WILL REDUCE ROT, BECAUSE IT DOES NOT TRAP WATER.



HEWN LOGS WITH A SADDLE NOTCH

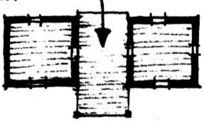
THIS JOINT COMBINES THE SIMPLICITY OF THE SADDLE JOINT WITH THE DRAINING ADVANTAGE OF THE V-NOTCH.

DOUBLE-DEN OR DOUBLE-PEN LOG HOUSE

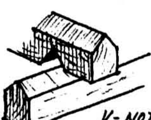
(CENTER HALL GAVE ADDED VENTILATION)

WILSON, ARKANSAS

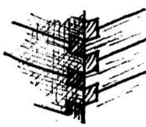
PLAN



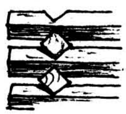
AS TIMBER-SHAPING TECHNOLOGY IMPROVED, TIGHTER AND MORE COMPLEX JOINTS WERE USED.



V-NOTCH

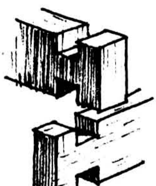


SQUARE NOTCH

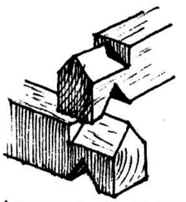


DIAMOND

DOVETAIL



DOUBLE NOTCH



INDENTED V-NOTCH

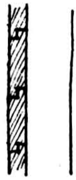
WOOD WALLS

ADVANCES IN WOOD SAWING AND MILLING TECHNOLOGY GREATLY REFINED THE WOOD FRAMING SYSTEMS AND ALSO BROUGHT ABOUT THE EXTENSIVE USE OF SAWN BOARDS AS A SIDING MATERIAL. A VARIETY OF TYPES AROSE IN AN EFFORT TO CREATE A TIGHT WALL WITH ROT-RESISTANT JOINTS.

EDGE LAP

CLAPBOARDS

BEVELED



RABBETED OR SHIPLAP

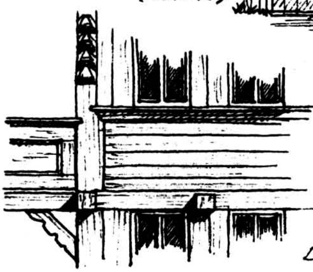
BOARD AND BATTEN:

WITH WOOD STRIPS,

WITH BAMBOO

THE SIDING AND ROOFING OF MANY OLD BARNS HAD SLIGHTLY OPEN JOINTS TO LET THE BARN BREATHE. IN THE RAIN, THE WOOD SWELLED AND CLOSED THE GAP.

NEW HAMPSHIRE FARMHOUSE WITH AN ATTACHED SHED (CA. 1840)



FARMHOUSE WALL
BERN, SWITZERLAND

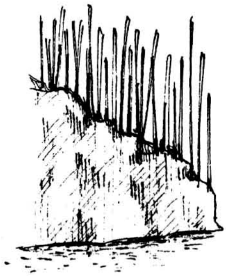
HORIZONTAL BOARDS WITH RECESSED BATTENS – BY FRANK LLOYD WRIGHT

WATTLE AND DAUB

THE USE OF MUD PLASTER (DAUB) OVER A MATRIX OF WOOD, REED, OR BAMBOO STRIPS (WATTLE) TO BUILD WALLS ACTUALLY PRE-DATES THE EGYPTIAN CULTURE.

HUNGARIAN PEASANT HOUSE

WATTLE AND DAUB WALL

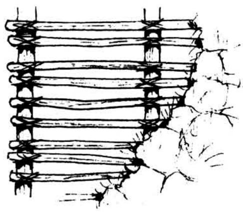


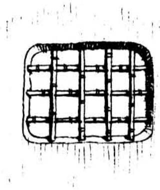
THE EARLIEST FORM OF MUD-PLASTERED WALL CONSTRUCTION WAS PROBABLY JACAL (MUD OVER VERTICAL PIECES PLANTED IN THE GROUND).

JACAL WALL, KEET SEEL, NAVAHO NATIONAL MONUMENT, ARIZONA

HORIZONTAL WOOD STRIPS LASHED TO POSTS AND THEN PLASTERED WITH MUD THAT HAS BEEN MIXED WITH STRAW TO HOLD IT TOGETHER

VENEZUELA



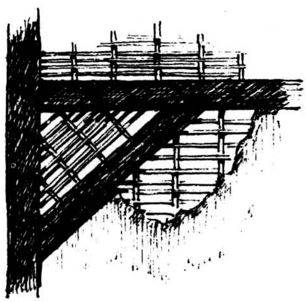


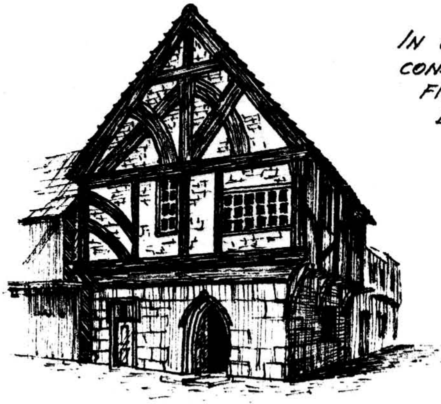
THE BAMBOO MESH IN THIS WALL HAS BEEN LEFT UNPLASTERED IN ONE SECTION TO LEAVE A WINDOW WITH A GRILLE.

JAPAN

A MORE ADVANCED USE OF THE WATTLE AND DAUB IS IN HALF-TIMBER CONSTRUCTION. THE WATTLE IS FRAMED INTO THE TIMBER STRUCTURE, THEN PLASTERED, LEAVING THE TIMBERS EXPOSED.

ENGLAND





IN OTHER HALF-TIMBER CONSTRUCTION, MASONRY FILLS IN THE WALL AREA BETWEEN THE TIMBERS.

BRICK INFILLED HALF-TIMBER HOUSE
NEWGATE, YORK
ENGLAND (CA. 1380)

A VERY COMMON, PRIMITIVE TYPE OF WALL IS THAT OF HAND-FORMED MUD COURSES.

NORTHERN IVORY COAST

COB (MUD MIXED WITH STRAW FOR ADDED STRENGTH) WAS A FAVORITE BUILDING MATERIAL IN MANY PARTS OF ENGLAND.

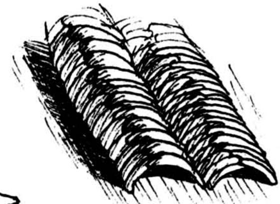
STONE ENDED COB HOUSE
DEVON, ENGLAND

WALLS OF TABBY, A MIXTURE OF LIME, SAND, WATER, AND AGGREGATE (BROKEN SHELLS), ARE COMMON IN OLDER HOMES IN THE SOUTHERN U.S. THE WALLS WERE FORMED BY POURING THE TABBY BETWEEN FORM BOARDS (SEE PAGE 103).

ST. AUGUSTINE, FLORIDA

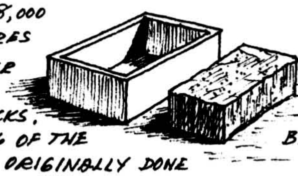
FROM MUD TO BRICK

SOME WASPS BUILD TUBULAR NESTS BY FASHIONING SMALL MUD CYLINDERS AND THEN LAYERING THEM TO CREATE THE ARCHED SHAPE OF THE NEST.



WASP'S NEST

FOR OVER 8,000 YEARS, CULTURES THE WORLD OVER HAVE BUILT WITH MUD BRICKS. THE SHAPING OF THE BRICKS WAS ORIGINALLY DONE BY HAND AND LATER WITH MOLDS. DURABILITY WAS INCREASED BY FIRING THEM.



BRICK AND MOLD
MALI

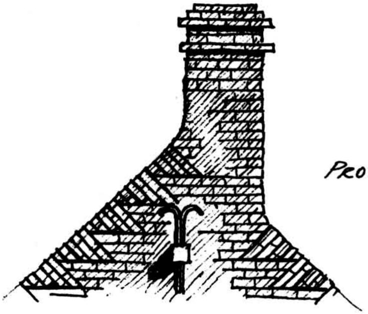
AFTER THE ARRIVAL OF THE SPANISH IN AMERICA THE PUEBLO INDIANS BEGAN BUILDING WITH ADOBE BRICKS RATHER THAN WITH HAND-SHAPED OR PUDDLED ADOBE.

PUEBLO DWELLING
NEW MEXICO (17TH CENTURY)

MUD BRICK WALL
AND PANTILE ROOF
VENEZUELA

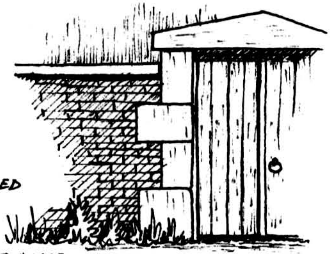
BECAUSE OF THEIR SQUARE AND REGULAR SHAPE, BRICKS ARE OFTEN USED IN CONJUNCTION WITH STONE TO MAKE SOLID, SQUARE CORNERS, DOOR AND WINDOW JAMBS, FLAT OR ARCHED LINTELS, SILLS, AND CHIMNEYS.

FLINT COBBLE AND BRICK HOUSE
NORFOLK, ENGLAND



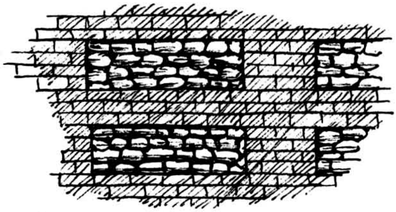
TUMBLED BRICKWORK SERVES AS BOTH A STRENGTHENING AND A DECORATIVE ELEMENT.

PROVINCE DU NORD, FRANCE



BRICK WALL WITH CUT STONE QUOINS GIVING ADDED SOLIDITY AT THE DOORWAY

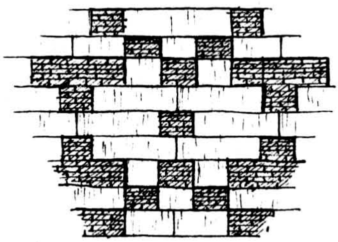
VAL D'OISE, FRANCE



DECORATIVE WALL TREATMENTS COMBINING AREAS OF STONE AND BRICK

BRAY, FRANCE

NORMANDY, FRANCE



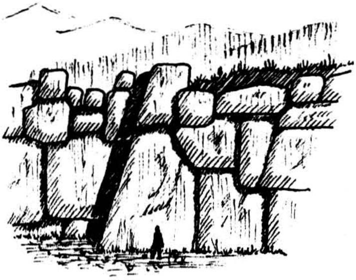
A COMMON PRACTICE IS TO REINFORCE THE CORNERS OF BRICK STRUCTURES WITH LARGE, CUT STONE QUOINS.

BRICK, STONE, AND THATCH HOUSE; TIDPIT HAMPSHIRE, ENGLAND

STONE

AS WELL AS BEING AN EFFICIENT WAY TO ENCLOSE SPACE (SEE PAGE 27), THE STONE BEEHIVE HUT DOES NOT REQUIRE THE COMPLEX FASHIONING OF CORNERS IN STONE.

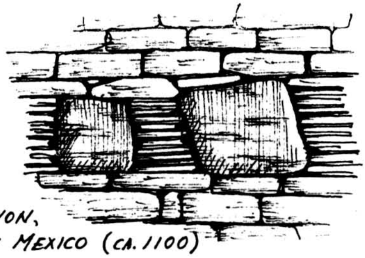
STONE AGE BEEHIVE HUT, IRELAND



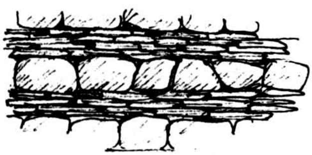
MASSIVE (NOTE SCALE FIGURE) AND INTRICATELY SHAPED AND FITTED STONES

SACSAHUAMAN, A STONE AGE INDIAN FORTRESS; CUZCO, PERU

WHERE A VARIETY OF STONE IS AVAILABLE, IT OFTEN INSPIRES DECORATIVE PATTERNS.



CHACO CANYON, NEW MEXICO (CA. 1100)



SLATE AND BOULDERS NORTHERN ENGLAND

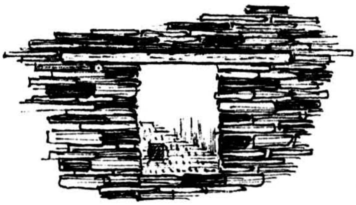
WALLS OF GREEN SLATE WITH QUOINS AND LINTELS OF SLATE PLACED ON EDGE

ELTERWATER CUMBRIA, ENGLAND

THE CORNICE, WINDOW JAMBS, AND TRIANGULAR ARCH ARE OF CUT STONE, WHILE THE WALL IS OF SLATE WITH BANDS OF RUBBLE STONE.

FRANCE

STONE SEGMENTAL ARCH
PENNSYLVANIA (18TH CENTURY)



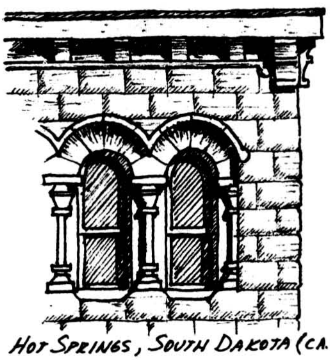
EXTENDED WOOD LINTEL FOR ADDED TENSILE STRENGTH

PUEBLO BONITO (CA. 1050)

CUT STONE LINTEL, OR FLAT ARCH

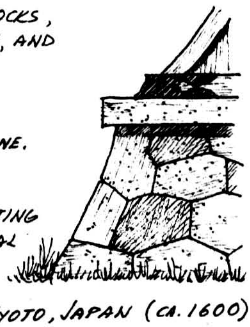
ENGLAND (CA. 1618)

SQUARED BLOCKS, CORNICEWORK, AND SEMICIRCULAR ARCHES - ALL CUT FROM LOCAL SANDSTONE.



HOT SPRINGS, SOUTH DAKOTA (CA. 1891)

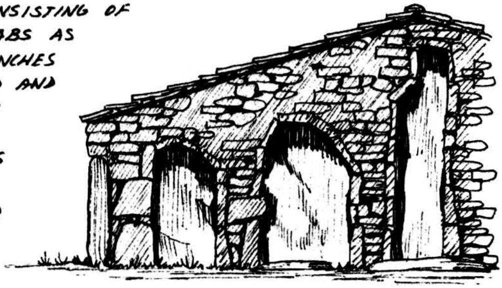
TIGHT-FITTING POLYGONAL STONEWORK

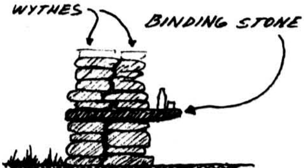


KYOTO, JAPAN (CA. 1600)

IN EASTERN PORTUGAL SOME HOUSES HAVE A STONE WALL SYSTEM CONSISTING OF HUGE GRANITE SLABS AS MUCH AS TWELVE INCHES THICK SURROUNDED AND HELD IN PLACE BY SMALLER STONES.

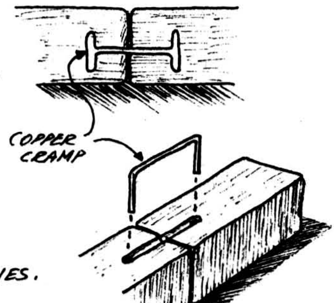
GRANITE SLABS ARE ALSO USED FOR ROOFING AND PAVING.





TO MAKE A THICK, SOLID STONE WALL, SEVERAL TIERS, OR WYTHES, OF STONE ARE BUILT AND TIED TOGETHER AT INTERVALS WITH BINDING STONES. SOMETIMES THESE STONES PROTRUDE AND ARE USED AS SHELVES OR STAIRS.

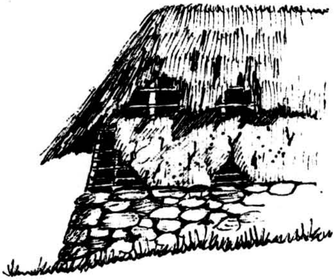
THE INCA INDIANS OF PERU WERE ACCOMPLISHED STONE MASONS AND DEVELOPED THE TECHNIQUE OF USING COPPER CRAMPS TO HOLD STONES TOGETHER. THE METHOD THEY USED MAY HAVE BEEN TO POUR MOLTEN COPPER INTO PREPARED HOLES IN THE STONES.



ANOTHER TECHNIQUE EMPLOYED BY THE INCAS WAS TO USE LONG STONES PROTRUDING FROM THE WALLS AS SUPPORTS FOR THE FLOOR JOISTS AND ROOF RAFTERS.

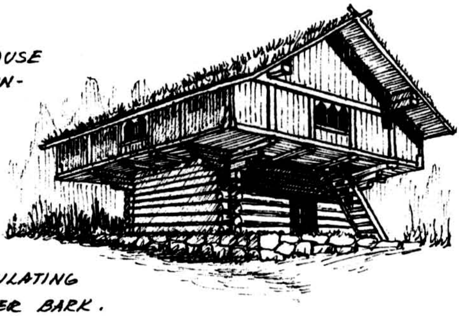
PERUVIAN ANDES
15th CENTURY

HYBRIDS:

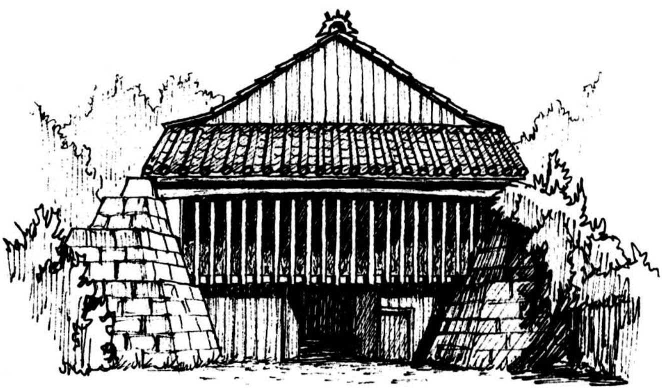


A TRADEMARK OF INDIGENOUS ARCHITECTURE IS THE USE OF A VARIETY OF MATERIALS IN WAYS THAT TAKE BEST ADVANTAGE OF THEIR PARTICULAR PROPERTIES.

THE BUILDERS OF THIS PRIMITIVE, DECAYING HOUSE BUILT A SOLID FOUNDATION OF STONE, A LIGHT FRAME OF WOOD, A WATERPROOF ROOF OF THATCH, AND AN UPPER, WEATHERTIGHT WALL OF WATTLE AND DAUB.



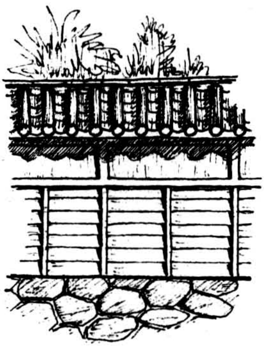
THIS NORWEGIAN HOUSE HAS A FIRM STONE FOUNDATION, A SOLID FIRST-FLOOR BARN AND STORAGE AREA OF LOGS, AN UPPER LIVING AREA WITH TIMBER FRAMING AND LIGHT PLANK WALLS, AND AN INSULATING ROOF OF SOD OVER BARK.



A BARN IN HAGI, JAPAN WITH A MASSIVE STONE BASE, LOWER AND GABLE WALLS OF BOARDS OVER A TIMBER FRAME, OPEN-SLATTED WALL IN LOFT FOR VENTILATION, AND A TILE ROOF

AN OLD SWISS FARMHOUSE WITH LOWER WALLS OF STONE; OVER THAT, A TIMBER FRAME WITH WATTLE AND DAUB INFILL, AND A TILE ROOF WITH DEEP OVERHANGS

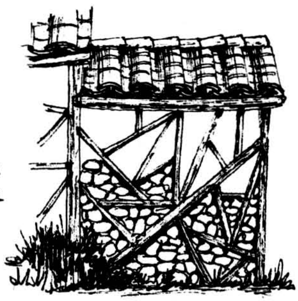
BERNESE FARMHOUSE
SWITZERLAND



A GARDEN WALL WITH A COMBINATION OF STONE, EDGE-LAPPED BOARDS WITH EXTERIOR BATTENS, PLASTER OVER BAMBOO, AND TILE

HAGI, JAPAN

POLE FRAME WITH ROCK INFILL AND PANTILE ROOF



GREECE

COTTAGE WITH STONE BASE, END WALLS, AND SEMICIRCULAR ARCHES, UPPER WALL OF HALF-TIMBER CONSTRUCTION, AND ROOF OF SHINGLES

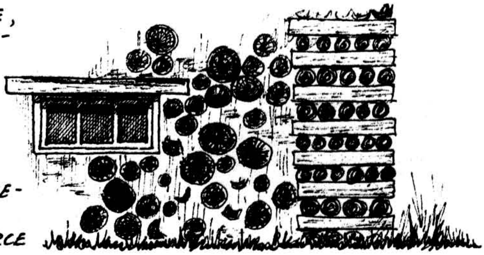
JOSSELIN, FRANCE

Other wall materials

The early settlers in the American mid-west had few building materials available so they often used blocks of sod to construct walls and to cover the roof.

Sod House; Nebraska (19th century)

Another simple, effective, and inexpensive system is the stovewood wall. In woodpile fashion the logs are stacked and mortared like stonework. Note the log quoins that reinforce the corner.

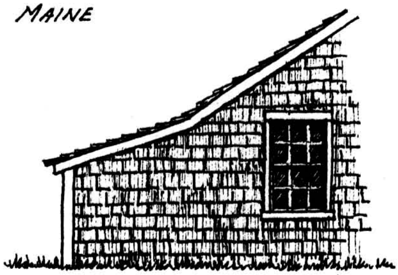


Stovewood Wall; Canada

In the late nineteenth and early twentieth centuries tin was use extensively as a cheap, weather-resistant covering for barns and homes.

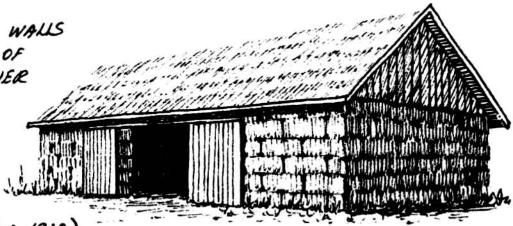
Tin shingles and panels Maine

Cedar shingles have been widely used for centuries as both a roof and a wall material because of their excellent weather-resistant qualities.



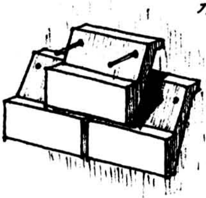
Shingled house; Hingham, Massachusetts (1720)

BARN WITH WALLS MADE OF BALES OF HAY STAKED TOGETHER AND ROOF MADE OF STRAW



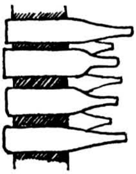
NEBRASKA (CA. 1910)

ENGLISH WALL TILES ARE LAPPED LIKE SHINGLES, LEAVING THE NAILS AND JOINTS PROTECTED.



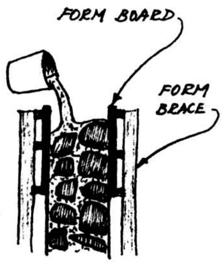
JAPANESE FLAT TILES ARE NAILED AT THE CORNERS AND THEN THE JOINTS ARE PLASTERED.

THE BOTTLE WALL

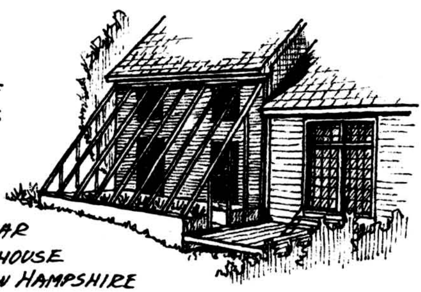


BOTTLES ARE LAID IN MORTAR. THEY ADMIT A BEAUTIFUL LIGHT BUT INSULATE POORLY.

IN A SLIP-FORMED STONE WALL ROCKS ARE PLACED BETWEEN THE FORM BOARDS AND CONCRETE IS POURED. LATER, THE FORM IS SLIPPED UP TO HOLD THE NEXT COURSE.

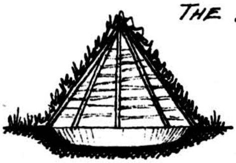


IN MANY AREAS SUBSTANTIAL HEATING CAN BE SUPPLIED BY THE USE OF GLASS ON THE SOUTH WALLS TO TRAP SOLAR HEAT INSIDE THE HOUSE.



CONTEMPORARY PASSIVE SOLAR HOUSE WITH ATTACHED GREENHOUSE
NEW LONDON, NEW HAMPSHIRE

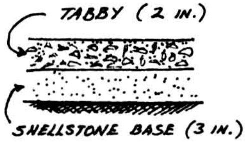
THE FLOOR



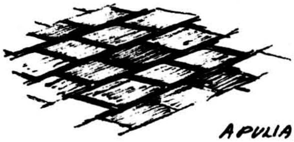
NEOLITHIC PIT HOUSE

THE SIMPLEST AND MOST COMMON FLOOR SURFACES FOUND IN PRIMITIVE DWELLINGS ARE OF PACKED EARTH AND ARE SOMETIMES COVERED WITH LEAVES, STRAW, SKINS, OR WOVEN MATS.

A FLOOR OF POURED MORTAR AND AGGREGATE MIXTURES, SUCH AS TABBY, GIVES A SURFACE THAT IS MORE DURABLE, CLEANER, AND DRIER. WHEN WORN, A NEW LAYER IS POURED ON TOP.

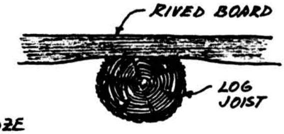


ST. AUGUSTINE, FLORIDA (CA. 1700)

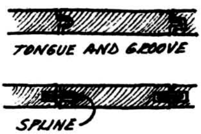


FLAT STONES ARE USED ALL OVER THE WORLD TO CREATE VERY DURABLE FLOORS AND PAVEMENTS.

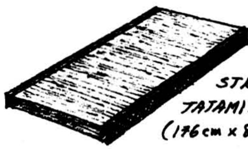
APULIA, ITALY (CA. 1600)



EARLY WOOD FLOORS WERE OF RIVED BOARDS RESTING ON LOG JOISTS THAT HAD BEEN MADE FLAT ON THE UPPER SIDE WITH AN ADZE OR A BROADAXE. THE BOARDS WERE TRIMMED OR SHIMMED AT THE JOIST TO KEEP THE FLOOR LEVEL.

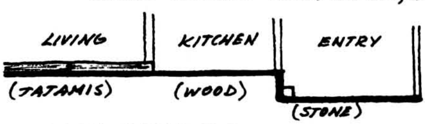


SPLINED AND TONGUE-AND-GROOVE BOARDS TIE THE FLOOR TOGETHER FOR GREATER STRENGTH AND FOR LESS WARPING.



STRAW TATAMI MAT (176 cm x 88 cm)

IN JAPAN, THE FLOOR MATERIAL DEFINES THE NATURE OF THE VARIOUS SPACES: EARTH OR STONE IN THE BARN AND ENTRANCE, WOOD IN THE KITCHEN AND WALKWAYS, AND TATAMI MATS IN THE LIVING AREAS. ROOM SIZES, AND SOMETIMES LAND AREAS, ARE MEASURED BY THE NUMBER OF TATAMI MATS HAVING AN EQUIVALENT AREA — FOR EXAMPLE, A SIX-MAT ROOM ACCOMODATES SIX TATAMI MATS.

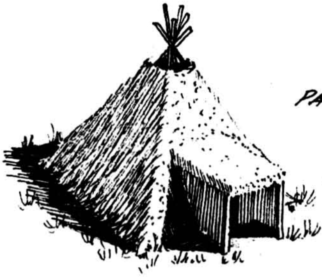


SECTION THROUGH A TRADITIONAL JAPANESE HOUSE

THE CHIMNEY

MANY PRIMITIVE DWELLINGS HAVE NO OUTLET SPECIFICALLY FOR THE SMOKE FROM THE FIRE. IN THE COMMUNAL HOUSES OF THE WAURA INDIANS, THE SMOKE INSIDE HELPS TO KEEP PESTS OUT, AND IT ALSO PROTECTS THE THATCH FROM INSECTS AS IT FILTERS OUT.

WAURA "MALOCA" (COMMUNAL HOUSE) BRAZIL

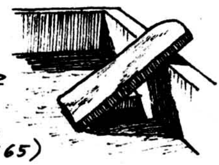


PAN-P'O DWELLING, CHINA (4000 B.C.) NOTE THE SMOKE HOLE AT THE PEAK OF THE EARTH-COVERED ROOF.

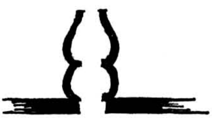
STONE SLAB USED AS A RAIN HOOD OVER THE SMOKE HOLE (ZUNI PUEBLO, NEW MEXICO)

IN MANY PRIMITIVE DWELLINGS AN OPENING IN THE ROOF ACTS AS THE ENTRANCE, THE SOURCE OF LIGHT, AND THE SMOKE HOLE.

HOUSE IN ANATOLIA, TURKEY (6000 B.C.)



STONE SLAB HOOD OVER SMOKE HOLE ST. AUGUSTINE, FLORIDA (CA. 1765)

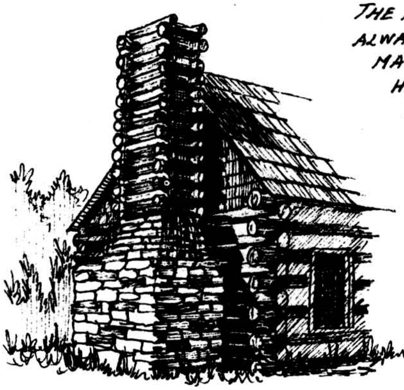


SHORT CHIMNEY MADE FROM OLD CLAY POTS ZUNI PUEBLO, NEW MEXICO

ADOBE FIRE-PLACE AND CHIM-NEY NEW MEXICO (CA. 1850)

DURING THE LAST SEVERAL CENTURIES THE FIREPLACE AND THE ENCLOSED CHIM-NEY HAVE REPLACED THE FIRE PIT AND THE SMOKE HOLE IN MOST AREAS.

THE FIREPLACE ITSELF IS ALWAYS MADE OF SOME MINERAL MATERIAL, BUT CHIMNEYS HAVE BEEN BUILT WITH A VARIETY OF MATERIALS.

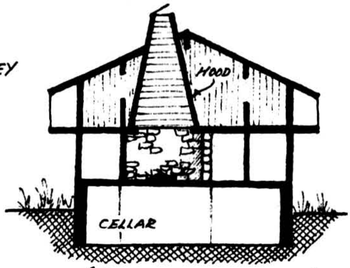


THE LOG CHIMNEY'S INTERIOR IS PLASTERED WITH MORTAR TO PROTECT IT FROM THE HEAT OF THE FIRE.

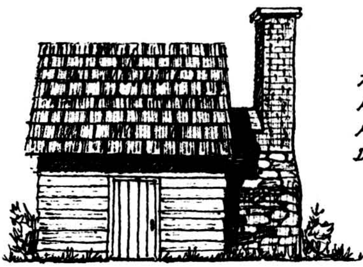
LOG CHIMNEY
INDIANA (CA. 1850)

THIS LARGE WOODEN CHIMNEY FORMS A FUNNEL-SHAPED HOOD OVER A WALK-IN STONE FIREPLACE.

SWITZERLAND



(SECTION THROUGH HOUSE)



VIRGINIA (18TH CENTURY)

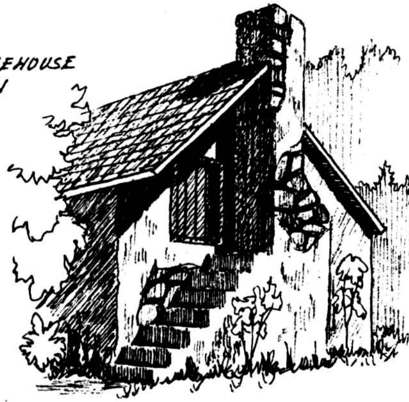
THIS BRICK CHIMNEY IS SET OUT FROM THE WALL TO REDUCE THE FIRE HAZARD AND THE HEAT INPUT DURING SUMMER.

THIS MASSIVE CHIMNEY SERVES A LARGE FIRST-FLOOR AND A SMALL UPSTAIRS FIREPLACE PLUS A BAKE OVEN.

VIRGINIA (18TH CENTURY)

Combined smokehouse and springhouse with a stairway built into the chimney

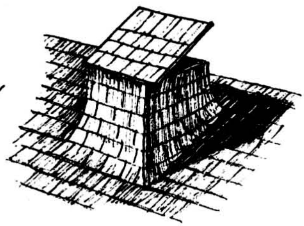
Chester County
Pennsylvania



Like curved walls (see page 125), round chimneys save the difficult task of making corners when working with flat stones, such as slate.

Plastered, round, stone chimney with slate rain shield (Northern England)

Shingled chimney with rain hood (Alps)

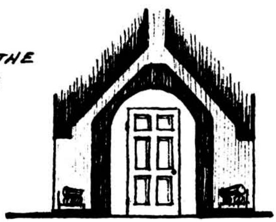


This chimney is integrated with the stuccoed stonework of the house.

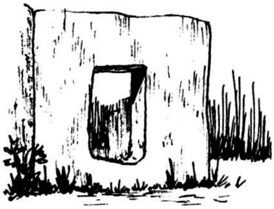
Chester County
Pennsylvania

A section taken through the vaulted hallway of this house shows how the two fireplace flues are joined in one chimney.

Ash Lawn, Virginia
(Designed by Thomas Jefferson)



THE DOORWAY



THE SIMPLEST DOORWAYS ARE SIMPLY HOLES IN THE WALL, LIKE THIS PREHISTORIC DOOR OPENING CARVED FROM A STONE SLAB.

MALTA

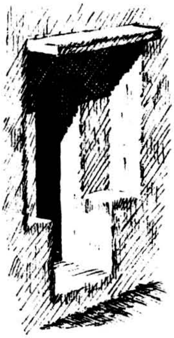
USING TAPERED JAMBS CAN REDUCE THE SIZE OF THE STONE LINTEL AND CAN ALSO MAKE THE OPENING APPEAR TALLER

MYCENAE, GREECE (1325 B.C.)

THE SHAPES OF THE OPENINGS BELOW ALLOW PEOPLE TO PUT THEIR HANDS ON THE SIDE AND SWING THEIR LEGS OVER THE HIGH THRESHOLD AND ALSO PERMIT SOMEONE TO ENTER WHILE CARRYING A WIDE LOAD.

MESAKIN DWELLING, SUDAN

PUEBLO BONITO, NEW MEXICO (11th CENTURY)



NARROW, RECESSED DOORS REDUCE THE AMOUNT OF SUNLIGHT ENTERING AND HEATING THE INTERIOR.

MYKONOS, GREECE

MANY AFRICAN DWELLINGS HAVE SMALL RAISED OPENINGS THAT MINIMIZE THE PASSAGE OF THE SUN'S HEAT AND ALSO DETER ANIMALS FROM CRAWLING IN.

NORTHERN CAMEROON

DOORS FOR SECURITY

MASSIVE WOOD DOOR WITH HEAVY, METAL REINFORCING PLATES AND HINGES

TOWER OF LONDON (CA. 1097)

AT THE ENTRANCE TO ITS NEST IN A DRY BANK THE TRAP-DOOR SPIDER CONSTRUCTS A SILK-HINGED DOOR BY CEMENTING SOIL PARTICLES. IT CLOSES UNDER ITS OWN WEIGHT TO NEATLY COVER THE NEST'S OPENING.

A PAIR OF HEAVY WOOD DOORS ("PORTON") USED TO CLOSE OFF THE PLAZA ("ZAGUAN") OF A HACIENDA AND CONTAINING A SMALLER, INSET DOOR, WHICH IS USED MORE OFTEN

THE SMALL (4 FEET HIGH) MOTHER-IN-LAW DOOR GIVES ACCESS TO AND FROM BOATS IN THE CANALS.

AMSTERDAM

THE ANCIENT PRACTICE OF ENTERING THE HOUSE VIA A FULLY ENCLOSED COURTYARD HAS REMAINED POPULAR FOR CENTURIES FOR REASONS OF SECURITY AND PRIVACY.

CHARLESTON
SOUTH CAROLINA (19TH CENTURY)

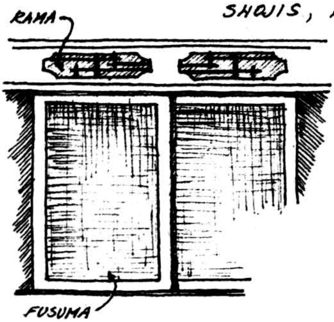
PRIVACY WITH VENTILATION

DOORWAY WITH PROTECTIVE DECORATIVE GRILLE IN THE TRANSOM OPENING, WHICH PERMITS VENTILATION.

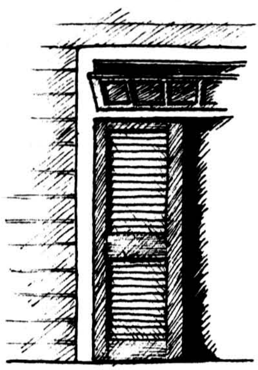
MORELOS, MEXICO

SLIDING, SLATTED FRAME IN THE TRANSOM CAN BE LEFT OPEN OR CLOSED.

JAPAN



THE TRADITIONAL DOOR IN JAPAN IS A SLIDING PANEL. THE EXTERIOR ONES, OR SHOJIS, ARE OF WOOD COVERED WITH RICE PAPER, WHILE THE INTERIOR ONES, OR FUSUMAS, ARE OF WOOD COVERED WITH A SOLID MATERIAL OR CLOTH. ABOVE THE FUSUMA IS OFTEN AN OPEN SPACE, OR RAMMA (USUALLY HAVING A DECORATIVE GRILLE WORK), FOR VENTILATION.

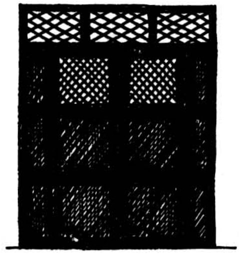


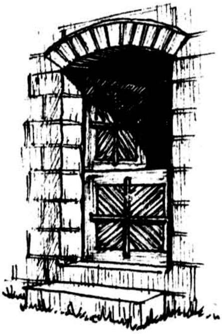
LOUVERED DOORS GIVE PRIVACY WHILE ALLOWING GOOD VENTILATION, AND THE TRANSOM WINDOW LETS IN LIGHT AND/OR FRESH AIR.

BERMUDA

DOORWAY WITH WOOD LATTICE SCREEN IN BOTH THE DOORS AND THE TRANSOM FOR LIGHT AND VENTILATION

VENEZUELA



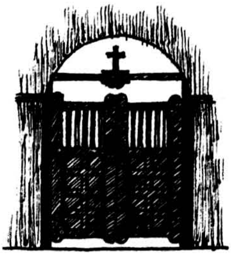


DUTCH DOOR WITH BOTTOM CLOSED TO KEEP ANIMALS OUT AND CHILDREN IN AND WITH TOP OPEN FOR LIGHT AND AIR

PENNSYLVANIA

SOLID LOWER DOOR AND BI-FOLD UPPER DOORS FOR A DUTCH DOOR EFFECT, PLUS A TRANSOM WINDOW

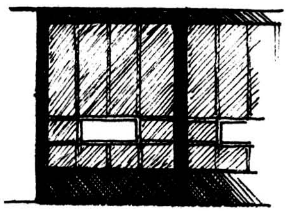
GREECE



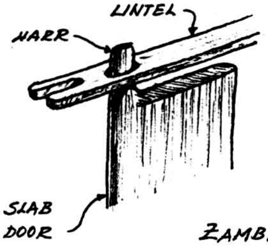
GRILLES ALLOW AIR AND VIEW THROUGH THE DOORS, WHICH ENCLOSE THE "ZAGUAN."

CALIFORNIA

THE SMALL GLASS INSERTS IN THESE SHOJIS CAN BE SLID OPEN FOR VENTILATION OR CAN BE COVERED BY SMALL SLIDING PANELS OF TRANSLUCENT RICE PAPER FOR PRIVACY. AS WINDOWS THEY OFFER A NICE VIEW FOR PEOPLE SEATED ON THE FLOOR.



JAPAN



THIS DOOR, MADE FROM A LARGE SLAB OF WOOD, HAS TWO PROJECTING LOBES, OR HARRS, WHICH ROTATE IN HOLES IN THE LINTEL AND THRESHOLD. THESE HARR-HUNG, OR PINTLE, DOORS WERE USED IN THE NEAR EAST MORE THAN 6,000 YEARS AGO.

ZAMBIA

LINTEL, OR "KAMOI," WITH ROUTED TRACKS FOR THE FUSUMAS

JAPAN

CLOTH USED FOR PRIVACY AND SHADING IN DOORWAY

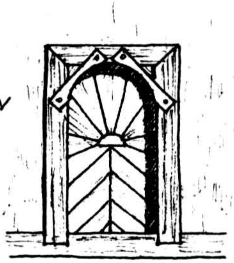
APULIA, ITALY

DOORWAY WITH RAIN HOOD

BUCKS COUNTY
PENNSYLVANIA (19th CENTURY)

PLAN OF DOORWAY SHOWING HOW THE DOUBLE DOORS FOLD AWAY INTO THE JAMBS

VISCHE, ITALY (15th CENTURY)



THE CORNER BRACES STIFFEN THE DOOR FRAME AND ALSO DEFINE THE ARCHED OPENING.

VASILOV,
CZECHOSLOVAKIA (1839)

THE WINDOW

THE ANCESTOR OF THE WINDOW IS THE ANCIENT WIND EYE, AN OPENING IN THE ROOF THROUGH WHICH SMOKE COULD ESCAPE.

MUD AND THATCH HUT WITH WIND EYE
NORTHERN NIGERIA

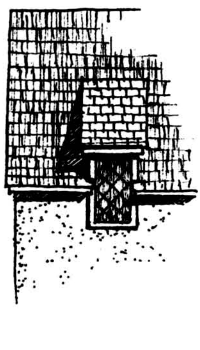
ROOF WINDOW FOR LIGHT AND VENTILATION

TAKAYAMA, JAPAN

A VARIETY OF ROOF WINDOWS, OR DORMERS, EVOLVED TO BRING LIGHT AND AIR INTO THE LOFT SPACES.

HAMPSHIRE, ENGLAND

KENT, ENGLAND



HALF DORMER

SAINT AUGUSTINE, FLORIDA (18TH CENTURY)

DORMER WINDOW WITH A HIPPED ROOF

WILLIAMSBURG, VIRGINIA (1730)

DORMER WINDOW IN
A GAMBREL ROOF

WEST MEDFORD,
MASSACHUSETTS
(18th CENTURY)

DORMER WITH
LONG, CATSLIDE ROOF

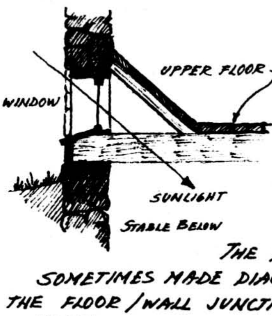
EPHRATA,
PENNSYLVANIA

HIPPED GABLE ROOF WITH A
SMALL WINDOW IN THE GABLET
TO BRING LIGHT AND AIR
INTO THE LOFT

ENGLAND

EYEBROW WINDOWS
BRING LIGHT AND AIR TO UPPER
LEVEL WITHOUT REQUIRING A FULL-
HEIGHT WALL.

NEW HOPE,
PENNSYLVANIA

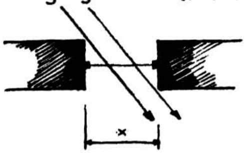


THE ANGLED BARN FLOOR ADMITS
LIGHT TO THE LOWER LEVEL FROM
WINDOWS ABOVE THE
FLOOR TIMBERS.

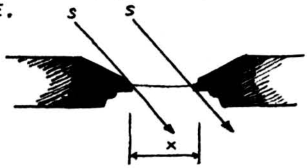
THE PUEBLO INDIANS
SOMETIMES MADE DIAGONAL HOLES AT
THE FLOOR/WALL JUNCTION TO ADMIT
LIGHT TO INTERIOR SPACES.

ZUNI PUEBLO, NEW MEXICO

BUILDERS DISCOVERED VERY QUICKLY THAT WITH BEVELED JAMBS, A WINDOW OF WIDTH x COULD ADMIT MUCH MORE SUNLIGHT (S) ENTERING AT AN ANGLE.



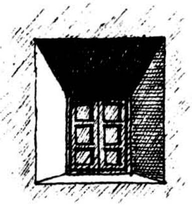
PRIMITIVE WINDOW WITH SQUARED JAMBS



MEDIEVAL BEVELED WINDOW

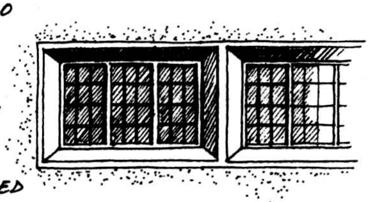
RECESSED WINDOW WITH ANGLED EXTERIOR JAMBS AND LINTEL

ALPS



WINDOW WITH ANGLED INTERIOR JAMBS AND SILL

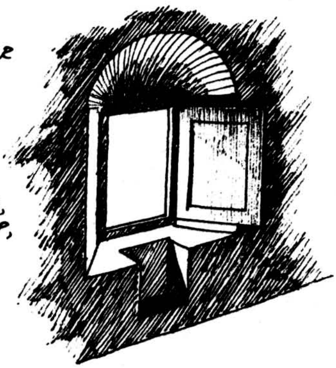
NEW MEXICO



WEAVER'S WINDOW: WINDOWS HAVING ANGLED STONE AND WOODEN FRAMES ADMIT EXTRA LIGHT FOR WEAVING. ENGLAND (1600's)

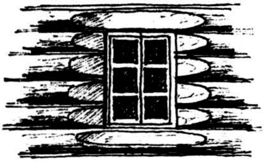
BEVELED AND VAULTED INTERIOR WINDOW FRAME

PENNSYLVANIA



ANGLED JAMBS, SCALLOPED AND VAULTED TOP, AND DEEP SILL WITH SEATS

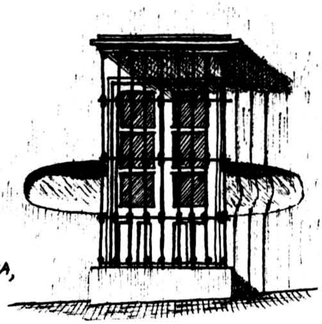
MICHOACAN, MEXICO



CABIN WALL WITH THE LOGS BEVELED AT THE WINDOW TO ADMIT MORE LIGHT

SAVO PROVINCE, FINLAND

PLAN



THE SCALLOPED RECESSES IN THIS WALL ALLOW A VIEW TO THE SIDE FOR PEOPLE-WATCHING FROM INSIDE.

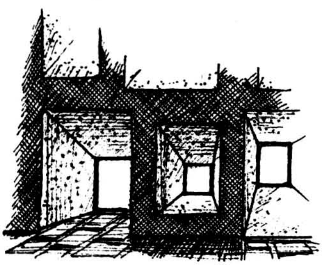
ARCOS DE LA FRONTERA, SPAIN

THIS RECESSED WALL BAND ALLOWS A SIMILAR SIDEWAYS VIEW THROUGH THE SMALL SECTION OF GLASS AT THE SIDE OF THE WINDOW.

SPAIN

METAL GRILLES GIVE SECURITY WHILE ADMITTING LIGHT AND AIR.

GUANAJUATO, MEXICO



A VARIETY OF WINDOWS WITH ANGLED JAMBS CREATE INTERESTING LIGHT PATTERNS INSIDE THIS CHAPEL.

CHAPEL AT RONCHAMP, FRANCE

THE MOST COMMON DEVICE FOR PROTECTING THE WINDOW FROM BOTH WEATHER AND ATTACKERS IS THE SHUTTER.

BOARD AND BATTEN SHUTTER
BERKS COUNTY, PENNSYLVANIA

PANEL SHUTTERS WITH DIAGONAL BOARD BACKING

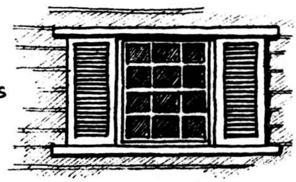
PEACH BOTTOM, PENNSYLVANIA

ARCHED PANEL SHUTTERS COVERING A WINDOW THAT HAS A VARIETY OF OPENING MODES

SIBERIA

SPLIT SHUTTERS FOR PARTIAL SHADING ALONG WITH VENTILATION

DEADWOOD, SOUTH DAKOTA

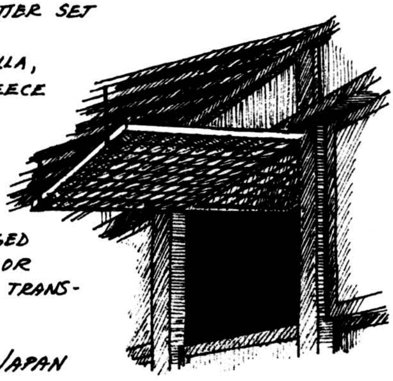


LOUVERED SLIDING SHUTTERS

NAGASAKI, JAPAN

HORIZONTALLY HINGED SHUTTER SET

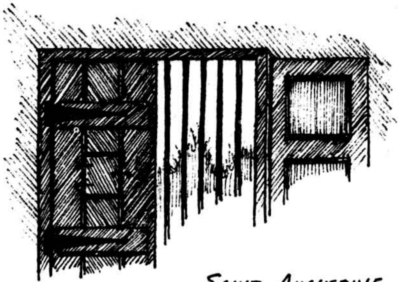
KAVALLA, GREECE



HORIZONTALLY HINGED OUTER SOLID SHUTTER, OR "SUTOMI," AND INNER TRANSLUCENT SHUTTER

JAPAN

INTERIOR SHUTTERS



A BARRED WINDOW WITH INTERIOR PANEL SHUTTERS REINFORCED WITH A BOARD-AND-BATTEN BACKING AND HAVING A SMALL INSET DOOR, OR WICKET, OUT OF WHICH ONE CAN PEEK.

SAINT AUGUSTINE, FLORIDA (18TH CENTURY)

SECTIONED WINDOW HAVING SMALL SHUTTERS WITHIN THE LARGER, FULL-LENGTH, INTERIOR SHUTTERS

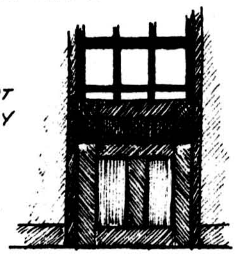
MICHOACÁN, MEXICO

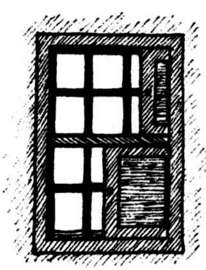
UPPER AND LOWER BI-FOLD INTERIOR SHUTTERS

CANTERBURY, NEW HAMPSHIRE (1811)

SHUTTERS THAT SLIDE VERTICALLY FROM BELOW THE WINDOW

CANTERBURY, NEW HAMPSHIRE (1831)





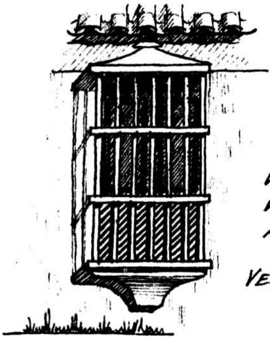
DOUBLE SLIDING INDIAN SHUTTERS, WHICH SLIDE INTO THE WALL

WILMOT FLAT, NEW HAMPSHIRE (19TH CENTURY)

LOUVERED SHUTTERS FOR SHADE, PRIVACY, AND VENTILATION

ITALY (14TH CENTURY)

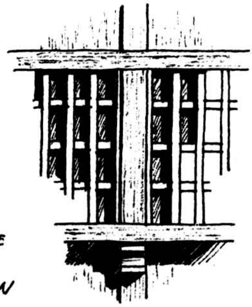
PENNSYLVANIA (19TH CENTURY)



LATTICEWORK IS WIDELY USED IN WINDOWS AS A SUNSCREEN AND TO GIVE SOME PRIVACY.

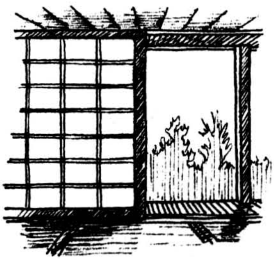
WINDOW WITH GRILLE AND LATTICE

VENEZUELA



WINDOW WITH AN ELABORATE WOOD LATTICE

KANAZAWA, JAPAN

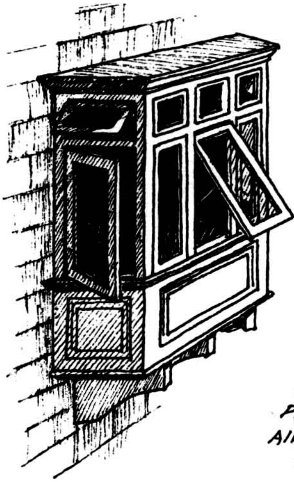


THE JAPANESE SHOJI SCREENS, WHICH ARE COVERED WITH TRANSLUCENT RICE PAPER, GIVE PRIVACY WHILE ADMITTING NATURAL LIGHT.

SHOJI SCREEN JAPAN

THE TRANSOM ABOVE THIS WINDOW LETS IN SOME LIGHT EVEN WHEN THE SHUTTERS ARE CLOSED.

HOLLAND

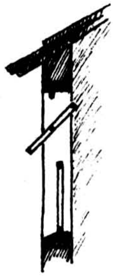


ENCLOSED BALCONY WITH AWNING WINDOWS ON THE FRONT AND CASEMENT WINDOWS ON THE SIDES TO ALLOW GREATER FLEXIBILITY TO MEET DIFFERENT WEATHER CONDITIONS

VALETTA, MALTA

THE UPPER SASH OF THIS SECOND-FLOOR WINDOW PIVOTS FOR GOOD AIR FLOW AND EASY CLEANING.

CUMBRIA, ENGLAND



THE POINTED UPPER SASH EXTENDS THIS DOUBLE HUNG WINDOW UP INTO THE TRIANGULAR ARCH.

CUMBRIA, ENGLAND

THIS TILTED DOUBLE HUNG WINDOW BRINGS LIGHT IN THROUGH THE SMALL WALL AREA BETWEEN THE ROOFS.

GRANTHAM, NEW HAMPSHIRE

CORNER WINDOW
HOLLAND

COMBINATION OF WICKET (WINDOW WITHIN A WINDOW) AND CASEMENT WINDOWS WITH VERTICALLY AND HORIZONTALLY HINGED SHUTTERS

SWITZERLAND

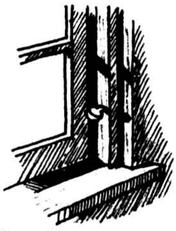
THICK WALLS ALLOW THE WINDOWS TO BE RECESSED EITHER FROM THE OUTSIDE FOR WEATHER PROTECTION OR FROM THE INSIDE TO CREATE A SEAT OR A SHELF.

DEEP SILL WITH A WINDOW SEAT

PENNSYLVANIA

SILL SHELF

CZECHOSLOVAKIA



WINDOW TRACKS HELD ONLY WITH THUMBSCREWS ALLOW EASY REMOVAL OF SASH FOR CLEANING.

NEW HAMPSHIRE

A TRANSOM SIMPLIFIES THE BUILDING PROCESS BY PUTTING A DOOR AND A WINDOW UNDER ONE LINTEL.

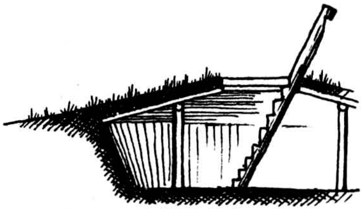
NEW YORK

THIS SMALL WINDOW WAS PLACED IN THE ROOF TO BRING NATURAL LIGHT TO THE STAIRWAY AND HALL.

PENNSYLVANIA

THE STAIRWAY

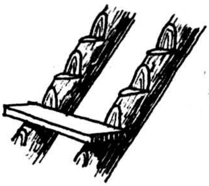
SINCE PALEOLITHIC TIMES SIMPLE STAIRWAYS HAVE BEEN BUILT BY CHOPPING A SERIES OF NOTCHES INTO LONG LOGS.



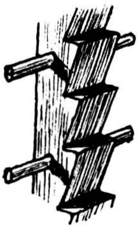
SALISH UNDERGROUND TRIBAL BUILDING

CANADA

NORWEGIAN LOG STAIR

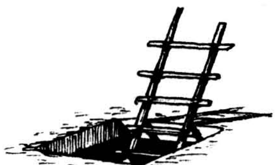


TWIN NOTCHED LOGS WITH STAIR TREADS BETWEEN



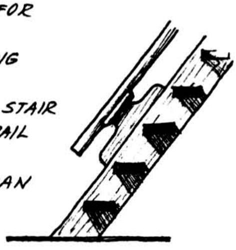
NOTCHED TIMBER LADDER WITH HAND RUNGS

PENNSYLVANIA



LASHED LADDER FOR ROOF ENTRANCE TO PUEBLO DWELLING

TAOS, NEW MEXICO



LADDER STAIR WITH HANDRAIL

KANAZAWA, JAPAN

LADDER THAT SWINGS DOWN FROM BETWEEN CEILING JOISTS

CANTERBURY, NEW HAMPSHIRE

BUILDERS IN MANY AREAS HAVE CHOSEN TO PUT THE STAIRWAY ON THE OUTSIDE OF THE STRUCTURE TO SAVE THE LIMITED INTERIOR SPACE.

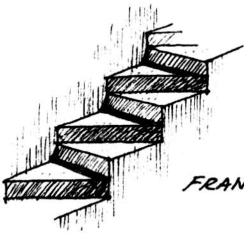
IRON AGE "CHIPURO" SHELTER
APULIA, ITALY

STONE HOUSE

LEMNOS, GREECE

STAIRWAY OF STONES PROJECTING FROM A MASONRY WALL

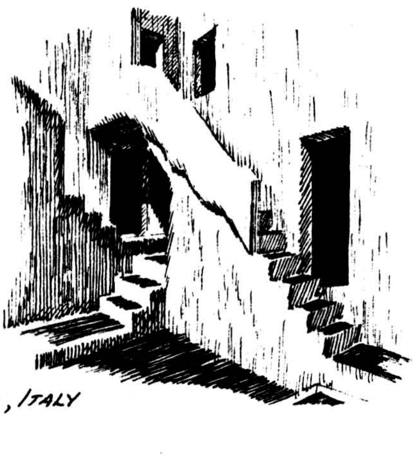
SWITZERLAND



STEPS OF CUT STONE BLOCKS

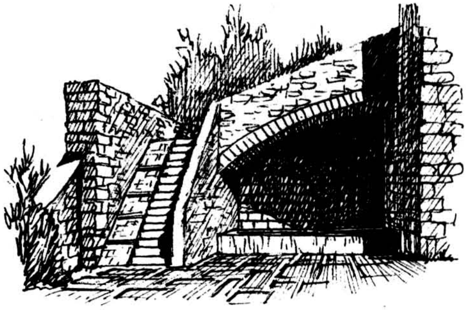
FRANCE

EXTERNAL STAIRWAYS ARE ESPECIALLY POPULAR IN WARMER CLIMATES.



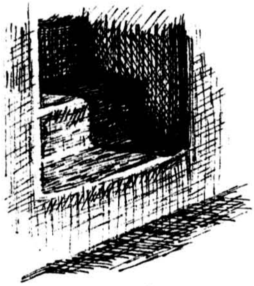
INTERTWINING NETWORK OF STAIRWAYS

SPERLONGA, ITALY



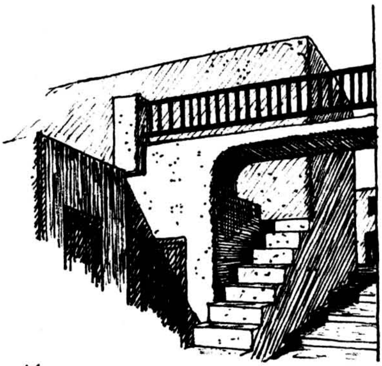
THIS ARCHED STAIRWAY HAS A RAMP FOR PACK DONKEYS BESIDE STEPS FOR PEOPLE AND LEADS UP TO A TANK ROOM ABOVE THE CISTERNS.

GUANAJUATO, MEXICO



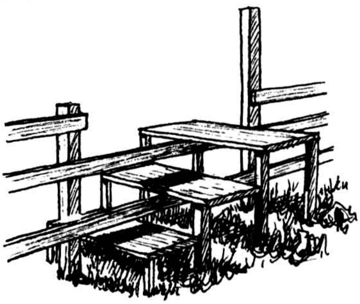
YEARS OF REPEATED WHITE-WASHING GRADUALLY SOFTEN THE SHARP ANGLE AT WHICH WALL AND STEP MEET.

SIENA, ITALY



STEPPED PEDESTRIAN RAMP ALONGSIDE A STAIRWAY LEADING TO A BALCONY CROSSWALK

MYKONOS, GREECE

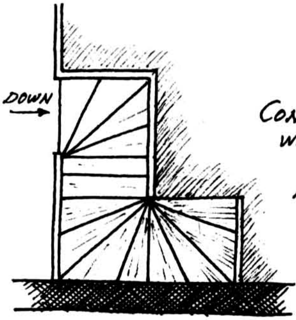


A STILE LETS PEOPLE CROSS A FENCE BUT KEEPS LIVE-STOCK IN, AND IT IS MUCH EASIER TO USE THAN A GATE, ESPECIALLY WHEN CARRYING SOMETHING.

EPHRATA, PENNSYLVANIA

ARCHED ADOBE STAIRWAY WITH STORAGE BELOW

SAN ANTONIO, TEXAS (19th CENTURY)

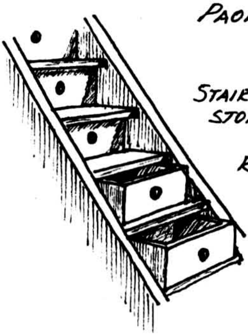


CONTEMPORARY SPIRAL STAIRWAY WITH DOUBLE TURN

NEW LONDON, NEW HAMPSHIRE

SPIRAL STAIRWAY SCULPTED BY WHARTON ESHRICK USING TENONED OAK LOG TREADS AND DRIFTWOOD RAILINGS

PAOLI, PENNSYLVANIA



STAIRWAY WITH STORAGE DRAWERS

RICHTERSWIL, SWITZERLAND (ca. 1756)

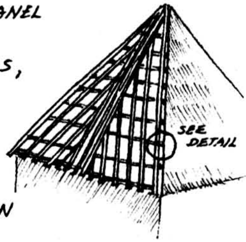
ENTRANCE TO CONTEMPORARY HOUSE BUILT OF MUD

BUILDING SYSTEMS

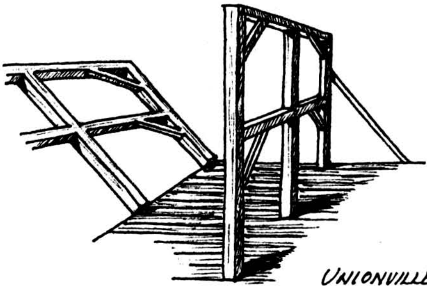
UNITIZED ROOF FOR EASY CONSTRUCTION AND TRANSPORTATION TO THE SITE

THIS STRUCTURAL ROOF PANEL IS BUILT ON THE GROUND, BY LASHING TOGETHER PALM LEAF RIBS, AND THEN HOISTED UP AND THATCHED.

DETAIL OF LASHING



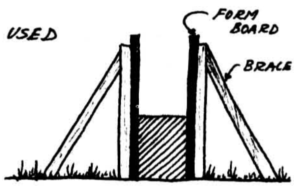
CAMEROON

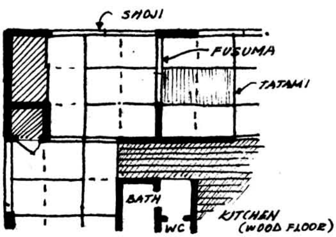


IN TIMBER FRAMING, WHOLE WALL SECTIONS, OR BENTS, ARE ASSEMBLED ON THE GROUND, TILTED INTO POSITION, BRACED, AND THEN FRAMED INTO THE OTHER BENTS.

UNIONVILLE, PENNSYLVANIA

FORM BOARDS HAVE BEEN USED OVER THE CENTURIES AS MOLDS FOR BUILDING WALLS OF MUD, TABBY (SEE PAGE 103), PACKED EARTH, STONES (SEE PAGE 131), AND CONCRETE.

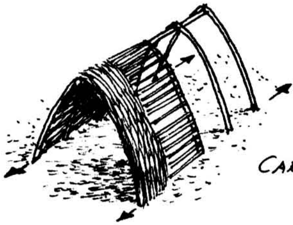




IN TRADITIONAL JAPANESE HOUSES, THE FLOOR PLAN, SHOJIS, AND FUSUMAS ALL FOLLOW A MODULAR GRID BASED ON THE TATAMI MAT (SEE PAGE 132).

Expansion

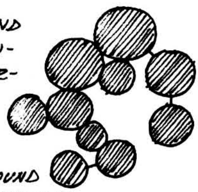
The intuitive, circular form of the neolithic beehive hut (right) precludes the simple expansion of the interior space,



but the rational, rectangular form offers the possibility of easy, linear growth (left).

Carib Indian structure, Guiana

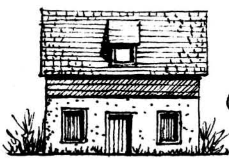
Another way to expand a dwelling is to build additional units that interface with the existing structure.



House compound
Cameroon

Vertical growth, as in the termite mound (above), is another effective mode of expansion.

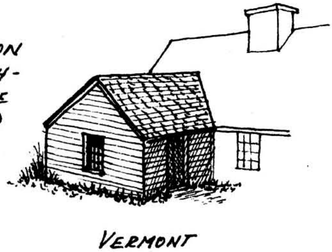
(ca. 1710)



(ca. 1750)

The early houses of St. Augustine, Florida were often expanded vertically by adding another floor above the tabby-walled first floor.

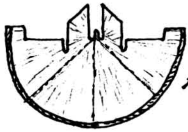
Other common expansion techniques are the lean-to (left) and the el (right).



Rhode Island

Vermont

MOBILE ARCHITECTURE



TEPEE COVER

TRAVOIS

THE TRAVOIS, DRAWN BY HORSES AFTER THEIR INTRODUCTION BY THE SPANISH, USUALLY CONSISTED OF TEPEE POLES BETWEEN WHICH THE TEPEE COVER (LEFT) WAS CARRIED WITH VARIOUS BELONGINGS.

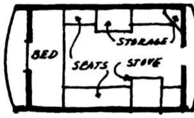
THE WALL PANELS OF MANY YURTS COLLAPSE LIKE A SCISSORS GATE FOR EASY TRANSPORTATION.

WALL OF MONGUL YURT

THE LARGE BEDOUIN TENTS ARE MADE TO BE EASILY CARRIED BY CAMELS.

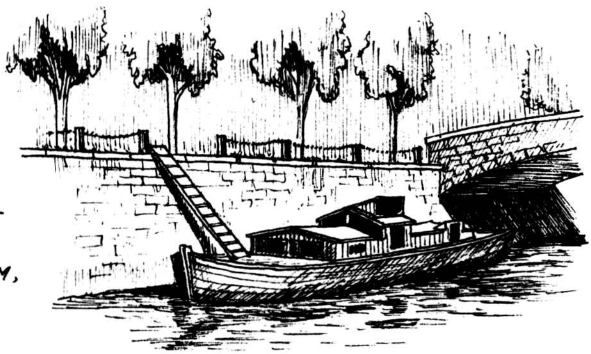
THE BOW-TOP ENGLISH GYPSY VAN HAS PROVISIONS FOR SLEEPING, COOKING, EATING, AND SITTING WHILE TRAVELING, AND IT PROTECTS AGAINST BAD WEATHER.

PLAN OF GYPSY VAN



BULGARIAN SLEIGH HUT

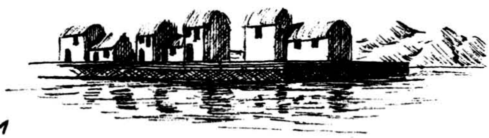
THE WOOD AND WATTLE-AND-DAUB SLEIGH HUTS OF THE BULGARIAN NOMADIC SHEPHERDS ARE LARGE ENOUGH TO HOUSE ENTIRE FAMILIES.



BARGE HOUSEBOAT

AMSTERDAM, HOLLAND

WHETHER BECAUSE OF LIMITED AVAILABLE LAND OR TOO HIGH A PRICE FOR IT, PEOPLE IN MANY PARTS OF THE WORLD HAVE CHOSEN TO LIVE ON THE WATER IN EVERYTHING FROM CONVERTED BARGES TO DWELLINGS BUILT ON ARTIFICIAL ISLANDS.



FLOATING VILLAGE BUILT ON A PLATFORM OF BAMBOO

YELLOW RIVER, CHINA (CA. 1668)

THE CHINESE EMPORER WU-TI (140 - 86 B.C.) HAD A FLOATING WOODEN FORTRESS THAT MEASURED 600 FEET ON A SIDE AND GARRISONED 2,000 MEN PLUS THEIR HORSES.

BIBLIOGRAPHY

ALLEN, EDWARD. STONE SHELTERS. CAMBRIDGE, MA: MIT PRESS, 1969.

ANDERSON, CARDWELL. "PRIMITIVE SHELTER." AIA JOURNAL, OCT. AND NOV., 1961.

ARTHUR, ERIC, AND WITNEY, DUDLEY. THE BARN. GREENWICH, CT: NY GRAPHIC SOC. BOOKS, 1972.

BALDWIN, J., AND BRAND, STEWART. SOFT TECH. NEW YORK: PENGUIN BOOKS, 1978.

BEMIS, A.F., AND BURCHARD, J. THE EVOLVING HOUSE. CAMBRIDGE, MA: TECH PRESS, 1931.

BRODERICK, ALAN HAUGHTON. "GRASS ROOTS." LONDON: ARCHITECTURAL REVIEW 686 (FEB. 1954).

BUNTING, BAINBRIDGE. EARLY ARCHITECTURE IN NEW MEXICO. ALBUQUERQUE: U. OF N. MEXICO PRESS, 1976.

BUTTI, KEN, AND PERLIN, JOHN. A GOLDEN THREAD. PALO ALTO, CA: CHESHIRE BOOKS, 1980.

CAMESASCA, ETTORE. HISTORY OF THE HOUSE (1ST AMERICAN ED.). NY: PUTNAM, 1971.

CARVER, NORMAN F. JR. ITALIAN HILLTOWNS. KALAMAZOO, MI: DOCUMAN PRESS, 1979.

CHAMBERLAIN, SAMUEL. DOMESTIC ARCHITECTURE IN RURAL FRANCE. NY: ARCHITECTURAL BOOK PUBLISHING CO., INC., 1981.

CURRANT, WILLIAM, AND SCULLY, VINCENT. PUEBLO ARCHITECTURE OF THE SOUTHWEST. AUSTIN, TX: U. OF TEXAS PRESS, 1971.

DUPONT, JEAN-CLAUDE. HABITATION RURALE AU QUÉBEC. MONTREAL: CAHIERS DU QUÉBEC/HURTUBISE HMH, 1978.

FITCH, JAMES MARSTON. AMERICAN BUILDING - 2: THE ENVIRONMENTAL FORCES THAT SHAPE IT. BOSTON: HOUGHTON MIFFLIN, 1972.

FITCH, JAMES MARSTON. "PRIMITIVE ARCHITECTURE." SCIENTIFIC AMERICAN, DEC. 1960.

FLETCHER, SIR BANNISTER. A HISTORY OF ARCHITECTURE ON THE COMPARATIVE METHOD. NY: CHARLES SCRIBNER'S SONS, 1963.

FOLEY, MARY MIX. THE AMERICAN HOUSE. NY: HARPER COLOPHON BOOKS, 1980.

VON FRISCH, KARL. ANIMAL ARCHITECTURE. NY: HARCOURT BRACE JOVANOVICH, 1974.

FUTAGAWA, YUKIO. VILLAGES AND TOWNS (VOLS. 1,3,5,6,8,9). TOKYO: ADA EDITA, 1973.

FUTAGAWA, YUKIO. WOODEN HOUSES NY: ABRAMS, 1979.

GARDI, RENÉ. INDIGENOUS AFRICAN ARCHITECTURE. NY: VAN NOSTRAND REINHOLD CO., 1973.

GARDINER, STEPHEN. EVOLUTION OF THE HOUSE. LONDON: CONSTABLE, 1975.

GASPARINI, GRAZIANO. LA CASA COLONIAL VENEZOLANA. CARACAS: U. CENTRAL DE VENEZUELA, 1962.

GAY, LARRY. HEATING WITH WOOD. CHARLOTTE, VT: GARDEN WAY PUBLISHING CO., 1974.
GIVONI, B. MAN, CLIMATE AND ARCHITECTURE. 2D ED. NY: VAN NOSTRAND REINHOLD, 1981.
GLASSIE, HENRY. FOLK HOUSING IN MIDDLE VIRGINIA. KNOXVILLE: U. OF TENNESSEE PRESS, 1975.
GRILLO, P.J. WHAT IS DESIGN? CHICAGO: U. OF CHICAGO PRESS, 1960.
GROPP, LOUIS. 48 ENERGY SAVING DESIGNS. NY: PANTHEON, 1978.
GSCHWEND, FEHLMAN, AND HUNZIKER. BALLENBERG: THE SWISS OPEN-AIR MUSEUM. AARAU, SWITZERLAND: AT VERLAG, 1982
HUBRECHT, R., AND DOYON, G. L'ARCHITECTURE RURALE ET BOURGEOISE EN FRANCE. PARIS: VINCENT, FREAL + CO, 1942.
KAHN, LLOYD (ED.). SHELTER. BOLINAS, CA: SHELTER PUBLICATIONS, 1973.
KAHN, LLOYD (ED). SHELTER II. BOLINAS, CA: SHELTER PUBLICATIONS, 1978.
KENNEDY, ROBERT WOODS. THE HOUSE AND THE ART OF ITS DESIGN. NY: REINHOLD, 1953.
KINZEY, B.Y., AND SHARP, H.M. ENVIRONMENTAL TECHNOLOGIES IN ARCHITECTURE. ENGLEWOOD CLIFFS, NJ: PRENTICE-HALL, INC., 1951.
KNOWLES, RALPH L. ENERGY AND FORM. CAMBRIDGE, MA: MIT PRESS, 1974.
KONSTANTINIDAS, N. ARIS. ELEMENTS FOR SELF-KNOWLEDGE. ATHENS: (PUBLISHED BY THE AUTHOR?), 1975.
MANUCY, ALBERT. THE HOUSES OF ST. AUGUSTINE, 1565-1821. TALLAHASSEE, FL: ROSE PRINTING CO., 1962.
MEANS, P.A. ANCIENT CIVILIZATIONS OF THE ANDES. NY: CHARLES SCRIBNER'S SONS, 1931.
MEGAS, ST. "STUDIES IN FOLK ARCHITECTURE." LAOGRAPHIA VOL. 26. ATHENS: SOCIETY OF HELLENIC LAOGRAPHY, 1969.
MERCER, ERIC. ENGLISH VERNACULAR HOUSES. LONDON: H.M. STATIONERY OFFICE, 1975.
MOHOLY-NAGY, SIBYL. NATIVE GENIUS IN ANONYMOUS ARCHITECTURE. NY: HORIZON PRESS, 1957.
MORGAN, LEWIS H. HOUSES AND HOUSE LIFE OF THE AMERICAN ABORIGINES. CHICAGO: U. OF CHICAGO PRESS, 1965.
MORSE, EDWARD S. JAPANESE HOMES AND THEIR SURROUNDINGS. NY: DOVER PUBLICATIONS, 1961.
OLGYAY, VICTOR. DESIGN WITH CLIMATE. PRINCETON: PRINCETON U. PRESS, 1963.
OLGYAY, ALADAR AND VICTOR. SOLAR CONTROL AND SHADING DEVICES. PRINCETON: PRINCETON U. PRESS, 1957.
OLIVER, PAUL. SHELTER IN AFRICA. NY: PRAEGER, 1971.
OLIVER, PAUL. SHELTER, SIGN AND SYMBOL. WOODSTOCK, NY: OVERLOOK PRESS, 1977.

PARKER, JOHN HENRY. A CONCISE GLOSSARY OF ARCHITECTURE. LONDON: PARKE + CO., 1882.
PENOYRE, JOHN AND JAYNE. HOUSES IN THE LANDSCAPE. BOSTON: FABER AND FABER, 1978.
RAPOPORT, AMOS. HOUSE, FORM AND CULTURE. ENGLEWOOD CLIFFS, NJ: PRENTICE-HALL, 1969.
RAYMOND, ELEANOR. EARLY DOMESTIC ARCHITECTURE OF PENNSYLVANIA. NY: WM. HELBURN, INC., 1931.
RIVIÈRE, G. H. MAISONS DE BOIS. PARIS: CENTRE GEORGES POMPIDOU, 1979.
ROBINSON, DAVID M. EXCAVATIONS AT OLYNTHUS: THE HELLENIC HOUSE. BALTIMORE: JOHNS HOPKINS PRESS, 1938.
RUDOFSKY, BERNARD. ARCHITECTURE WITHOUT ARCHITECTS. NY: DOUBLEDAY + CO., INC., 1964.
RUDOFSKY, BERNARD. NOW I LAY ME DOWN TO EAT. NY: ANCHOR PRESS (DOUBLEDAY), 1980.
RUDOFSKY, BERNARD. THE PRODIGIOUS BUILDERS. NY: HARCOURT BRACE JOVANOVICH, 1977.
SAFDIE, MOSHE. FORM AND PURPOSE. BOSTON: HOUGHTON MIFFLIN, 1982.
SCHOENAUER, NORBERT. 6,000 YEARS OF HOUSING (VOL 1). NY: GARLAND STPM PRESS, 1981.
SERGEANT, JOHN. FRANK LLOYD WRIGHT'S USONIAN HOUSES. NY: WATSON-GUPTILL PUBLICATIONS, 1975.
SEVERIN, TIMOTHY. VANISHING PRIMITIVE MAN. NY: AMERICAN HERITAGE PUBLISHING CO., 1973.
SHIPWAY, VERNA COOK AND WARREN. THE MEXICAN HOUSE: OLD AND NEW. NY: ARCHITECTURAL BOOK PUBLISHING CO., 1960.
SKURKA, NORMA, AND NAAR, JOHN. DESIGN FOR A LIMITED PLANET. NY: BALLANTINE BOOKS, 1976.
SLOANE, ERIC. AN AGE OF BARNS. NY: BALLANTINE BOOKS, 1967.
SLOANE, ERIC. A REVERENCE FOR WOOD. NY: FUNK AND WAGNALLS, 1965.
SPRIGG, JUNE. BY SHAKER HANDS. NY: ALFRED A. KNOPF, INC., 1975.
WESLAGER, C. A. THE LOG CABIN IN AMERICA. NEW BRUNSWICK, NJ: RUTGERS U. PRESS, 1969.
ZOOK, NICHOLAS. MUSEUM VILLAGES OF THE U.S.A. BARRE, MA: BARRE PUBLISHING, 1971.

"A fascinating and handsome book . . . filled with valuable information." —*Choice*

Commonsense Architecture

JOHN S. TAYLOR

Vernacular folk architecture, with its straightforward responses to both environmental forces and people's needs, has much to teach us. *Commonsense Architecture* provides a catalogue of examples: pen-and-ink drawings of hundreds of different buildings and design details, accompanied by a hand-lettered text that explains the principles at work.

The author first illustrates how buildings respond to external environmental factors such as climate. In the second section, he describes ways in which various activities such as sleeping and cooking are accommodated within dwellings. The final section investigates materials and construction practices.

Thousand-year-old earth-sheltered houses built in China, passive solar heating ideas used by the Pueblo Indians over nine hundred years ago, natural air-conditioning systems built in the Middle East in the thirteenth century, modular building techniques used in Japan for centuries—these are just a few of the refreshingly practical design ideas here, developed by history's anonymous builders. They illustrate ways of making efficient and economical use of material, capital, and human resources—working *with* natural forces rather than against them.

A native of southeastern Pennsylvania, John S. Taylor received a Bachelor of Architecture degree from the University of Virginia in 1971. He returned to Pennsylvania to go into business as a designer and contractor and to teach. After moving to New Hampshire in 1975, he developed and taught an energy education program called "Energy Perspectives." He now designs passive solar houses and continues to teach part time.

COVER DESIGN BY JAY J. SMITH

Norton
W • W • NORTON & COMPANY NEW YORK • LONDON

FPT ISBN 0-393-30330-6 $5.95 USA

$7.95 CAN.